Green Garments Guidebook

Improving Environmental Performance
in Saipan's Garment Manufacturing Industry

A Joint Project of:

SAIPAN GARMENT MANUFACTURERS ASSOCIATION

Tetra Tech EM Inc.

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PREFACE

Tetra Tech EM Inc. (Tetra Tech) prepared this Guidebook with funding from the U.S. Environmental Protection Agency (EPA), administered through the Commonwealth of Northern Mariana Islands (CNMI) Division of Environmental Quality (DEQ), and endorsed by the Saipan Garment Manufacturers Association (SGMA). Dave Hodges and Jim Callier managed the project for CNMI DEQ; Patrick Wooliever and Marcella Thompson (Tetra Tech) were the primary authors of this guidebook and may be contacted at (415) 222-8240 or patrick.wooliever@ttemi.com.

The Green Garments Project aims to help member companies improve their competitiveness and environmental performance by identifying best management practices (BMP) that conserve water and energy, use less-toxic chemicals, and minimize waste. Companies that implement the recommended BMPs can realize multiple benefits, including: cost savings, improved worker conditions, reduced risk of regulatory problems, and decreased impact on the local environment and community.

The following SGMA member companies dedicated significant time and resources to the development of this Guidebook by providing Tetra Tech with facility tours and real operating data:

- Concorde Garment Manufacturing
- Jin Apparel
- Michigan
- Onwel Manufacturing
- US CNMI Development
- Commonwealth Garment Manufacturing
- Marianas Garment Manufacturing
- Mirage Saipan
- United International

The Green Garments Project also solicited the participation of international stakeholders to broaden the impact of this project, including the Global Reporting Initiative (GRI) team developing the Apparel and Footwear Sector Supplement and major retailers to raise awareness and increase demand-side support for the project. Ultimately, the Green Garments Project hopes to help improve the environmental performance of garment manufacturers in Saipan and elsewhere in this global industry.

A SNAPSHOT OF A GREEN GARMENT FACTORY (EXECUTIVE SUMMARY)

Instead of the customary “Executive Summary,” the Green Garments Project believes that readers of this Guidebook are most interested in what features characterize an environmentally-efficient garment factory and how the facility they work in, or with, compares. Whether you are from within the industry and trying to assess your factory relative to competitors, or an interested customer, auditor, or regulator, what features characterize a garment manufacturer doing business in a manner that is “ahead of the curve” environmentally?

Such an evaluation is inherently subjective and complex, and the resulting “score” or “grade” is always relative. But often the evaluation exercise is more valuable than the final determination: collecting data and asking questions reveals the weaknesses in environmental management and implementation. So, what does a “Green Garment” factory look like? This Guidebook offers two measuring sticks:

1. Benchmarks for the most important resources used in each of the four Guidebook environmental focus areas: energy, water, solid waste, and hazardous materials.
2. A checklist of environmental best management practices (BMP) for garment manufacturing factories.

Environmental Benchmarks for Saipan Garment Factories

One goal of the Green Garments Project was to determine quantitative measures of the environmental impacts of a garment factory. The environmental footprint of a typical Saipan garment factory can be divided between activities associated with (a) manufacturing processes and (b) on-site dormitories. Using actual operating data from nine Saipan garment factories between May 2004 and May 2005, the Green Garments Project determined normalized averages for energy use, water use, and solid waste generation.

When available, this Guidebook also provides comparative data from other garment manufacturers in Asia and the U.S. mainland. Benchmarks derived from simple statistical methods and judgments are also provided for Saipan garment factories. Recognizing that even with all other variables being equal, the factories have different requirements for resources (for example, some factories perform more labor-intensive finishing processes). While the benchmarks for each metric are aggressive, the Green Garments project still believes they are attainable by most, if not all the garment factories.

Lastly, the data show that the environmental impact of on-site worker housing dormitories is a smaller, but still significant component of the typical overall garment factory in terms of water and energy use. Because factories control the operations and resulting environmental impact of on-site dormitories, this Guidebook also includes recommendations for this facet of the garment factories.

ENVIRONMENTAL FOOTPRINT FOR SAIPAN GARMENT FACTORIES*

Environmental Focus Area	Manufacturing Operation per 1,000 pieces		Employee Housing per resident, per day	
	Average	Benchmark	Average	Benchmark
Energy Use kilowatt hour (kw-hr)	435	271	4.55	2.99
Water Use gallons (gal)	1,773	1,086	72.3	55.6
Solid Waste Generation pounds (lbs)	200	126	NA	
Hazardous Chemical Use pounds (lbs)	NA			

* Because garment factories in Saipan only cut and sew bulk fabrics to create garments, this data excludes the environmental impacts associated with textile manufacturing. While not insignificant, the environmental impacts associated with cutting and sewing are less substantial than those resulting from fabrication and dyeing processes.

NA Not available. Data on solid waste generation and hazardous material use from the Garment Factory Dormitories was unavailable, but also very small compared to the manufacturing component.

Garment Manufacturing Environmental Checklist

The following Garment Manufacturing Environmental Performance Checklist is designed to assist garment factories and their retail customers in integrating environmental performance monitoring into existing management programs. Global Reporting Initiative (GRI) environmental performance indicators have been noted for each category, and additional information for most recommended BMPs can be found throughout this Guidebook.

This checklist is wholly based on findings from the Green Garments Project in Saipan, which encompasses the garment manufacturing processes described in Section 2 of this Guidebook. Therefore, the checklist does not directly address other environmental impacts that are associated with the textile manufacturing process. Furthermore, this checklist should be viewed only as a starting point for sustainable practices and used to initially gauge the environmental performance of garment factories. Even if a garment factory has achieved everything on the checklist, countless other opportunities exist to further minimize environmental impacts. Lastly, the checklist is specific to local conditions in Saipan and its application in other geographic areas or non-tropical climates may require modification to better reflect locally available pollution prevention (P2) opportunities and operating conditions.

KEY FINDINGS OF THE GREEN GARMENTS GUIDEBOOK

In analyzing the raw data that supports the charts and tables in this section, it is important to keep the "big picture" firmly at the forefront of your thinking, namely:

- **The big P2 opportunities are not exotic.** The four environmental focus areas in this Guidebook highlight reduction opportunities that are not unique to the industry, nor do they require hard-to-find equipment or poorly understood techniques. Bottom line?

  1. **Conduct an energy audit and prioritize actions.**
  2. **Conduct a water audit and prioritize actions.**
  3. **Segregate and recycle fabric scraps.**
  4. **Identify and eliminate the cause of spots quickly and use what spot cleaners are required sparingly. Eliminate chlorinated solvents if at all possible.**

- **Garment manufacturing is a smaller piece of the overall garment environmental footprint.** The portion of the overall garment footprint represented by most garment manufacturing factories like those in Saipan is smaller than that of textile manufacturing, the other major part of producing garments that includes fabrication, dyeing, weaving and spinning. Garment manufacturing activities—including cutting, sewing, ironing and packing—are still significant and should be controlled and made efficient, but their impacts area smaller and less chemical-intensive.

- **Cost savings are abundant.** The cost/benefit analysis for the P2 opportunities in three of the focus areas, energy, water, and solid waste, are relatively easy to determine and the payback period for nearly all of them is between 6 months and 2 years (...and shorter if CUC rates, diesel prices, or tipping fees continue to increase).

GARMENT MANUFACTURING ENVIRONMENTAL PERFORMANCE CHECKLIST

SAIPAN GREEN GARMENTS PROJECT

POLICIES AND PROCEDURES

Addresses GRI Governance Structure and Management Systems requirements.

1. Does the organization track environmental performance metrics?	☐ Yes	☐ No
2. Does the organization have an environmental policy statement endorsed by executive management?	☐ Yes	☐ No
3. Has the organization implemented an environmental management system?	☐ Yes	☐ No
3.1 If yes, is it ISO 14001 certified?	☐ Yes	☐ No

ENERGY USE

GRI Environmental Performance Indicators EN3, EN4

4. Does the organization track a normalized energy-use metric? If yes, attach documentation and record normalized average energy use per month here: ________________	☐ Yes	☐ No
5. Has the organization performed a formal energy audit and identified energy efficiency opportunities?	☐ Yes	☐ No
6. Has the organization conducted a formal study to determine appropriate lighting levels for each process or task?	☐ Yes	☐ No
7. Has the organization optimized current lighting systems using any of the following? (Check all that apply.)	☐ Adjust light proximity ☐ Task lighting ☐ Automatic light controls ☐ Cleaning/maintenance ☐ Group replacement ☐ Other:	
8. Has the organization upgraded lighting systems with any of the following energy-efficient technologies? (Check all that apply.)	☐ Electronic ballasts ☐ Hybrid ballasts ☐ T8 or T5 lamps ☐ Compact fluorescent ☐ LED exit signs ☐ Other:	

ENERGY USE *(continued)*

GRI Environmental Performance Indicators EN3, EN4

9. Does the organization have a documented environmentally preferable purchasing policy that includes preference to energy-efficient products? If yes, describe below:

10. Has the organization installed an energy-efficient heating or cooling system? If yes, describe below:

11. Does the organization operate a boiler for steam generation or other use? ☐ Yes ☐ No

    If yes, does the organization have a written maintenance schedule to inspect the system for steam leaks? ☐ Yes ☐ No

    If yes, describe any upgrades or programs the organization has implemented to improve the energy-efficiency of the boiler.

WATER USE

GRI Environmental Performance Indicator EN5

12. Does the organization track a normalized water-use metric? ☐ Yes ☐ No

    If yes, attach documentation and record normalized average water use per month here: ________________

13. Does the organization have a documented leak detection program? ☐ Yes ☐ No

14. Does the organization have an on-site laundry operation? ☐ Yes ☐ No

    If yes, does the organization track the water used per pound of material washed? If available, specify here: ____________________ ☐ Yes ☐ No

    If yes, indicate whether the organization has implemented any of the following water conservation technologies (check all that apply).

    ☐ Batch washer system
    ☐ Water recovery tanks
    ☐ Ozone washing
    ☐ Other: ____________

WATER USE *(continued)*

GRI Environmental Performance Indicator EN5

15. Does the organization operate a boiler for steam generation or other use? ☐ Yes ☐ No

    If yes, is a boiler condensate recycling system installed? ☐ Yes ☐ No

16. Do bathroom facilities for employees used **during normal operating hours have low-flow features**? ☐ Yes ☐ No

    If yes, indicate whether the organization has implemented any of the following water conservation technologies <u>for toilets</u> (check all that apply).

    - ☐ Low-flush toilet *(1.6 gallons per flush)*
    - ☐ Early closure valve
    - ☐ Weighted flapper
    - ☐ Dual flush device
    - ☐ Displacement bag
    - ☐ Toilet dam

17. Does the organization provide bathroom and shower facilities for use by residents in on-site dormitories? ☐ Yes ☐ No

    If yes, indicate whether the organization has implemented any of the following water conservation technologies <u>for toilets</u> (check all that apply).

    - ☐ Low-flush toilet *(1.6 gallons per flush)*
    - ☐ Early closure valve
    - ☐ Weighted flapper
    - ☐ Dual flush device
    - ☐ Displacement bag
    - ☐ Toilet dam

    If yes, do the installed showerheads use less than 2.2 gallons of water per minute? ☐ Yes ☐ No

GARMENT MANUFACTURING ENVIRONMENTAL PERFORMANCE CHECKLIST
SAIPAN GREEN GARMENTS PROJECT

SOLID WASTE GENERATION

GRI Environmental Performance Indicators EN11

18. Does the organization track a normalized solid waste metric? ☐ Yes ☐ No

    If yes, attach documentation and record normalized average solid waste generation per month here:

    ____

19. Does the organization recycle scrap garment materials? ☐ Yes ☐ No

20. Indicate which commodities the organization recycles (check all that apply).
    - ☐ Aluminum cans
    - ☐ Batteries
    - ☐ Cardboard
    - ☐ Glass
    - ☐ Scrap metals
    - ☐ Other: ____________
    - ☐ Other: ____________

HAZARDOUS CHEMICAL USE

GRI Environmental Performance Indicators EN1, EN11, EN13

21. Does the organization maintain an electronic inventory of all hazardous chemicals used on site? ☐ Yes ☐ No

22. Does the organization track a normalized hazardous chemical use metric? ☐ Yes ☐ No

    If yes, attach documentation and record normalized average hazardous chemical use per month here:

    ____

23. Does the organization have a spot removal operation? ☐ Yes ☐ No

    If yes, refer to the spot remover/solvent MSDS to specify the health and safety characteristics of the product (check all that apply).
    - ☐ Carcinogenic
    - ☐ Teratogenic/Mutagenic
    - ☐ Neurotoxic

GARMENT MANUFACTURING ENVIRONMENTAL PERFORMANCE CHECKLIST

SAIPAN GREEN GARMENTS PROJECT

ENVIRONMENTAL COMPLIANCE

GRI Environmental Performance Indicators EN16

24. Has the organization previously had incidents of, or fines associated with noncompliance of applicable environmental laws and regulations? If yes, describe below: ☐ Yes ☐ No

25. Specify the local environmental regulatory agencies below:

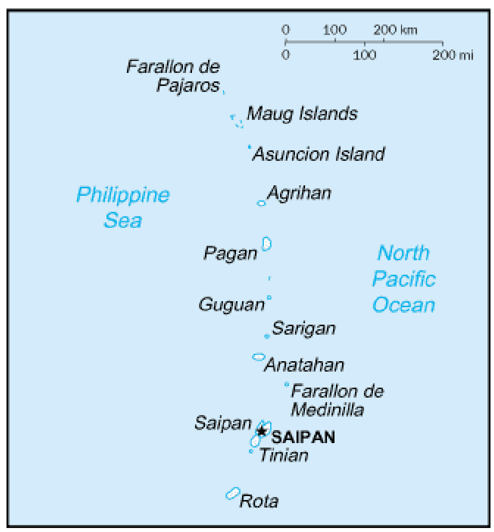
1.0 GARMENT MANUFACTURING IN SAIPAN

Over the past 20 years, Saipan has become an important player in the world garment manufacturing industry, which has grown and evolved to meet consumers' ever-changing and burgeoning demand worldwide for the latest clothing styles. At the same time, the industry sector has come under increasing scrutiny as a result of high-profile examinations of labor practices and working conditions at manufacturing facilities around the globe. To meet pricing pressures, the most successful retailers have exercised their clout to demand lower wholesale prices from suppliers and have sourced goods from a wider and wider pool of manufacturers. In this squeeze between cost and globalized sourcing of goods, rapid change, and extraordinarily competitive markets, the environmental effects of the industry sector have been hard to define, evaluate, and control. The industry, represented in Saipan by the Saipan Garment Manufacturers Association (SGMA), has responded to the scrutiny of outside organizations by developing a code of conduct that delineates standards for the treatment of workers, living conditions and worker rights.

> **In the squeeze between cost and globalized sourcing of goods, rapid change, and extraordinarily competitive markets, the environmental effects of the industry sector have been hard to define, evaluate, and control.**

The next step in improving performance is to more explicitly address the environmental issues associated with the industry's practices. When considering the long-term potential for a sustainable and successful garment manufacturing industry in Saipan, it is essential to view the industry's "environmental performance" as intertwined with other issues such as working conditions, living conditions, <u>and</u> manufacturing efficiency and profit. This Guidebook demonstrates this relationship and provides recommendations to improve environmental performance across the industry.

FIGURE 1-1 | COMMONWEALTH OF NORTHERN MARINANA ISLANDS MAP



Saipan is the capitol of the Northern Mariana Islands, a chain of 14 islands in the Western Pacific.

1.1 Green Garments Project

The Green Garments Project is a partnership between the Commonwealth of the Northern Mariana Islands (CNMI) Department of Environmental Quality (DEQ) and SGMA, intended to help member companies improve their competitiveness and environmental performance by identifying best management practices (BMP) that conserve water and energy, use less-toxic chemicals, and minimize waste. Companies that implement the recommended BMPs can realize multiple benefits, including: cost savings, improved worker conditions, reduced risk of regulatory problems, and decreased impact on the local environment and community.

This Green Garments Guidebook is based on the findings of P2 assessments conducted at nine SGMA member garment manufacturers (see Figure 1-2). As part of the project, participating companies provided tours of their respective facilities and shared actual operating data on several key production and environmental performance metrics. As a result, this Guidebook quantifies the environmental impacts of the industry and provides recommendations that are both practical and directly applicable to the industry.

FIGURE 1-2 | GREEN GARMENTS PROJECT SUMMARY

Project Phase	Description
Phase I: **Data Collection and P2 Audit**	▪ A preliminary Green Garments survey was used to collect basic company information and assess potential environmental focus areas. ▪ Additional production and environmental data was collected to determine baseline performance (discussed in Section 3). ▪ On-site pollution prevention (P2) assessments—including facility tours, operator interviews, and records review—were conducted at 9 garment manufacturing factories, and 3 other laundry, and screen printing facilities.
Phase II: **Develop Green Garments Guidebook**	▪ The Green Garments Guidebook was developed based on the results of the P2 assessments, facility-provided operational data, and research specific to the garment sector. The Guidebook includes a full description of recommended BMPs and tips for successful implementation, expected results, cost and savings, and applicable vendor information and contacts. ▪ The Green Garments Guidebook was reviewed by SGMA member companies, various CNMI employees, and other garment industry professionals.

1.2 Garment Manufacturing and Global Trade[1]

After a 10-year transition period, the World Trade Organization (WTO) quota restrictions for garment products entering the United States were lifted beginning January 1, 2005. As in many other countries vying in the worldwide garment industry, garment manufacturers in

[1] Summarized from "Understanding the World Trade Organization—Textiles: Back in the Mainstream." Available online at: http://www.wto.org/english/thewto_e/whatis_e/tif_e/agrm5_e.htm.

Saipan have been directly impacted by the demand-side shift resulting from this change in the global marketplace. From 1974 to 1995, the worldwide textile and garment trade was governed by the Multifibre Arrangement (MFA), a framework for bilateral agreements or unilateral actions that established quotas limiting textile and garment imports into countries whose domestic industries were facing serious damage from rapidly increasing imports. Contrary to General Agreement on Tariffs and Trade (GATT) principles, the MFA was replaced with the WTO's Agreement on Textile and Clothing (ATC), which sought to fully integrate the sector into normal GATT rules by January 1, 2005. In particular, the ATC terminated the textile and garment import quotas and prohibited importing countries from discriminating among exporters.

The end of these import quotas has meant that the demand for goods produced in Saipan is no longer influenced by international agreements on trade. Instead, new market equilibrium has emerged as countries previously restricted by the MFA compete for business without artificial limits on product demand. Competing factories in China pay wages that are a fraction of those on the U.S. mainland and far less than the Northern Marianas minimum wage of $3.05 per hour. As a result, China has seemingly flooded the market with lower-cost garment manufacturing services. Saipan's garment factories have felt this pinch with each phase of the ATC, and the results are evident by the declining membership in SGMA: 11 members during the Green Garments Project, down from 34 member garment factories in 1999. Saipan's total garment sales, which reached a high of $1.07 billion in 1999, had dropped to $786 million by 2004, and SGMA estimates that total sales for 2005 will not exceed $500 to $650 million.[2]

The End of the Multifibre Agreement—What it Means for Saipan

The elimination of textile and garment import quotas ultimately means that garment manufacturers in Saipan are now participating in a wholly competitive global market. The resulting economic implications require SGMA companies to operate as efficiently as possible to overcome structural differences in labor costs. The Green Garments Project is intended to help member companies improve their competitiveness and environmental performance by identifying BMPs that positively impact the bottom line by conserving water and energy, using less-toxic chemicals, and minimizing waste.

2 "Saipan's Garment Industry Hit by WTO," Islands Business, April 2005. www.islandsbusiness.com/archives/

2.0 OVERVIEW OF GARMENT MANUFACTURING OPERATIONS

Global consumers are often largely unaware of the resources, processes, and infrastructure required to grow, manufacture, and deliver the goods they purchase. The following sections summarize the processes required to turn bulk fabric into wearable garments ready for sale in retail stores throughout the world. The descriptions also provide a process overview for those unfamiliar with garment manufacturing; sources that provide even more detailed descriptions of these processes are included in Section 10.0, References and Further Reading.

2.1 Manufacturing Processes

Garment manufacturing processes include all activities from the point when textiles are received at the factory, to when retail-ready garments are shipped to the distributor. Some processes—such as fabric relaxing, cutting, and sewing—occur in the manufacturing of all garments. Other optional processes may also be performed as specified by the customer, including such things as embroidering, screen printing, and laundering. Depending on the size of the manufacturing facility, some garment manufacturers choose to subcontract those optional processes.

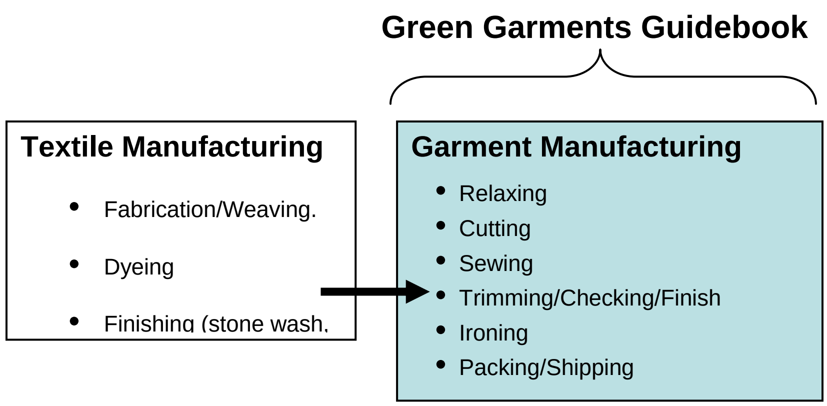


Figure 2-1 provides a brief summary of the major processes required to manufacture bulk textiles into retail-ready garments. Additional information for each of these processes is included in Sections 2.1.1 through 2.1.8.

FIGURE 2-1 | GARMENT MANUFACTURING PROCESS OVERVIEW

Receiving

- Garment factories receive fabrics from overseas textile manufacturers.
- Material is temporarily stored in a warehouse until needed for manufacturing.

FIGURE 2-1 | GARMENT MANUFACTURING PROCESS OVERVIEW

Fabric Relaxing

- Fabric bolts are unrolled to allow material to relax and contract.
- Fabric relaxing minimizes shrinkage during washing.

Spreading, Form Layout, and Cutting

- The fabric is cut into uniform plies and spread onto the cutting surface.
- Forms are then laid out on the top of the spread, and the fabric is cut to the pattern shapes.
- Cutting is performed manually or using a computerized system.

Embroidery and Screen Printing

- Optional customer-requested services may be performed to put logos or other embellishments on garments.

Sewing

- Garments are sewn in an assembly-line manner, with the garment becoming more complete as it progresses down the sewing line.
- This step is labor-intensive.

Spot Cleaning and Laundry

- Cosmetic flaws, stains, or other spots identified on an assembled garment may be cleaned using steam, hot water, or chemical stain removers.
- Customers may require a garment to be fully laundered after it is sewn and assembled.

Ironing

- Each garment is manually pressed and then folded prior to packaging.

Packaging and Shipping

- Garments are tagged, sized, and packaged according to customer specifications and then shipped to client distribution centers.

2.1.1 Receiving

Garment factories receive fabric from overseas textile manufacturers in large bolts with cardboard or plastic center tubes or in piles or bags. The fabric typically arrives in steel commercial shipping containers and is unloaded with a forklift. Garment factories often have a warehouse or dedicated area to store fabric between arrival and manufacturing.

2.1.2 Fabric Relaxing

"Relaxing" refers to the process that allows material to relax and contract prior to being manufactured. This step is necessary because the material is continually under tension throughout the various stages of the textile manufacturing process, including weaving, dyeing, and other finishing processes. The relaxing process allows fabrics to shrink so that further shrinkage during customer use is minimized.

Garment manufacturers perform the relaxing process either manually or mechanically. Manual fabric relaxing typically entails loading the bolt of fabric on a spinner and manually feeding the material through a piece of equipment that relieves tension in the fabric as it is pulled through. Mechanical fabric relaxing performs this same process in an automated manner.

Many garment manufacturers will also integrate quality assurance into this process to ensure that the quality of the fabric meets customer standards. This step is performed by manually spot-checking each bolt of fabric using a backlit surface to identify manufacturing defects such as color inconsistency or flaws in the material. Fabrics that fail to meet customer standards are returned to the textile manufacturer.

2.1.3 Spreading, Form Layout, and Cutting

After fabric has been relaxed, it is transferred to the spreading and cutting area of the garment manufacturing facility. The fabric is first cut into uniform plies and then spread either manually or using a computer-controlled system in preparation for the cutting process (see Figure 2-2). Fabric is spread to:

- allow operators to identify fabric defects;
- control the tension and slack of the fabric during cutting; and
- ensure each ply is accurately aligned on top of the others.

The number of plies in each spread is dependent on the fabric type, spreading method, cutting equipment, and size of the garment order.

Next, garment forms—or patterns—are laid out on top of the spread, either manually or programmed into an automated cutting system. Lastly, the fabric is cut to the shape of the garment forms using either manually operated cutting equipment or a computerized cutting system.

FIGURE 2-2 | INCLUDE PICTURES OF SPREADING, FORM LAYOUT, OR CUTTING

Saipan garment factories perform both manual cutting (left) and automated cutting systems (above).

2.1.4 Embroidery and Screen Printing

Embroidery and screen printing are two processes that occur only if directly specified by the customer; therefore, these processes are commonly subcontracted to off-site facilities. Embroidery is performed using automated equipment, often with many machines concurrently embroidering the same pattern on multiple garments. Each production line may include between 10 and 20 embroidery stations. Customers may request embroidery to put logos or other embellishments on garments (see Figure 2-3).

FIGURE 2-3 | EMBROIDERY

Embroidery machinery with multiple stations.

Screen printing is the process of applying paint-based graphics to fabric using presses and textile dryers. Specifically, screen printing involves sweeping a rubber blade across a porous screen, transferring ink through a stencil and onto the fabric. The screen printed pieces of fabric are then dried to set the ink. This process may have varying levels of automation or may largely be completed at manually operated stations. Like embroidery, screen printing is wholly determined by the customer and may be requested to put logos or other graphics on garments or to print brand and size information in place of affixing tags.

2.1.5 Sewing

Garments are sewn in an assembly line, with the garment becoming more complete as it progresses down the sewing line (see Figure 2-4). Sewing machine operators receive a bundle of cut fabric and repeatedly sew the same portion of the garment, passing that completed portion to the next operator. For example, the first operator may sew the collar to the body of the garment and the next operator may sew a sleeve to the body. Quality assurance is performed at the end of the sewing line to ensure that the garment has been properly assembled and that no manufacturing defects exist. When needed, the garment will be reworked or mended at designated sewing stations. This labor-intensive process progressively transforms pieces of fabric into designer garments.

2.1.6 Spot Cleaning and Laundry

In addition to identifying manufacturing defects, employees tasked with performing quality assurance are also looking for cosmetic flaws, stains, or other spots on the garment that may have occurred during the cutting and sewing processes. Spots are often marked with a sticker and taken to a spot-cleaning area where the garment is cleaned using steam, hot water, or chemical stain removers.

Some customers request that a garment be fully laundered after it is sewn and assembled; therefore, garment factories often have an on-site laundry or have subcontract agreements with off-site laundry operations. Commercial laundry facilities are equipped with at least three types of machines: washers, spinners, and dryers. Some facilities also have the capability to perform special treatments, such as stone- or acid-washing.

FIGURE 2-4 | GARMENT SEWING ASSEMBLY LINES AND IRONING STATIONS

Typically, large rooms of sewers sit in lines each doing separate sequential tasks (left). The final step prior to packing is ironing (above).

2.1.7 Ironing

After a garment is fully sewn and assembled, it is transferred to the ironing section of the facility for final pressing (see Figure 2-4). Each ironing station consists of an iron and an ironing platform. The irons are similar looking to residential models, but have steam supplied by an on-site boiler. Workers control the steam with foot pedals and the steam is delivered via overhead hoses directly to the iron. In most facilities, the ironing platforms are equipped with a ventilation system that draws steam through the ironing table and exhausts it outside the factory.

2.1.8 Packaging and Shipping

In the last steps of making a product retail-ready, garments are folded, tagged, sized, and packaged according to customer specifications. Also, garments may be placed in protective plastic bags, either manually or using an automated system, to ensure that the material stays clean and pressed during shipping. Lastly, garments are placed in cardboard boxes and shipped to client distribution centers to eventually be sold in retail stores.

2.2 Supporting Operations

As is the case with many industries, garment manufacturing requires multiple support operations to enable production in the facility. Many of these support operations are common to any manufacturing industry, such as administrative functions, facility and equipment maintenance, and boiler and backup power generator operation. The garment factories also commonly operate and maintaining on-site employee dormitories. Often the scale of the support operations is proportional to the production of the facility.

Figure 2-5 provides a brief summary of the support operations for a garment manufacturing facility. Additional information for each of these processes is included in Sections 2.2.1 through 2.2.5. Not all support operations are present at every garment factory.

FIGURE 2-5 | SUPPORT OPERATIONS FOR GARMENT MANUFACTURING

Administrative Offices

- Processing order and preparing invoices
- Conducting marketing and sales
- Managing human resources

Steam Generation

- Onsite boilers centrally generate steam to support ironing operations.

FIGURE 2-5 | SUPPORT OPERATIONS FOR GARMENT MANUFACTURING

Power Generation

- On-site diesel generators provide back-up power, as needed.

Food Preparation

- Meals are prepared on-site for employees.
- Kitchens are equipped to meet basic food storage, preparation, and cleaning needs.

Employee Housing

- On-site dormitory-style housing is often available to employees at larger garment factories.
- Rooms are most often designed with shared bathrooms and kitchen areas.

2.2.1 Administrative Offices

The administrative offices associated with a garment manufacturing facility are typically proportional to the size of the manufacturing operation (i.e. larger factories require more administrative support). Administrative staff manages corporate functions such as human resources, finance and accounting, billing, health and safety, and environmental compliance. Offices are equipped with basic technologies and amenities, such as computers, facsimile machines, printers, filing equipment, desk space, and meeting rooms. In some instances, retail customers may also maintain on-site administrative space for quality assurance personnel.

2.2.2 Steam Generation

All garment factories had an on-site boiler to centrally generate steam for garment ironing. In most facilities, the ironing boards are attached to a ventilation system that captures the heat emitted from the iron and exhausts it to the outside environment. The quantity and size of boilers located on-site is proportional to the manufacturing operation.

2.2.3 Power Generation

Saipan garment factories also maintain and operate on-site diesel-fueled generators as a source of backup power. The generators are primarily used when (1) island demand for Commonwealth Utility Corporation (CUC) electricity service exceeds capacity or (2) a typhoon temporarily causes a power outage.

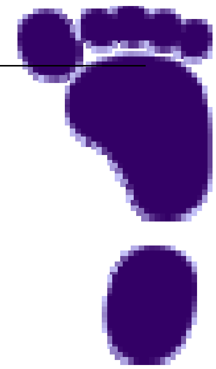
2.2.4 Food Preparation

Most Saipan garment factories had an on-site kitchen to prepare meals for employees. Kitchens are typically equipped with refrigerators and freezers, a food preparation area, ovens, propane-fueled stoves, and several large sinks. Meals are served in cafeteria-style manner during set dining hours. Limited food preparation may also occur in the shared kitchen areas in dormitories.

2.2.5 Employee Housing

Several Saipan garment manufacturers offer on-site housing for employees. Typically resembling dormitories or military barracks, employees may share a room with up to 5 other employees (determined by the square footage of the room). Housing facilities often have shared kitchen and bathroom areas, though most often a sink is located in each worker room. However, rooms with a private bathroom may be available for management employees.

3.0 ENVIRONMENTAL FOOTPRINT OF A GARMENT



Environmental footprint is a measure of impact on the global environment. Much as a foot leaves an impression on beach sand, manufacturing activities impact the environment. The environmental footprint of a manufacturing facility encompasses anything that impacts the earth including transporting supplies and workers and finished goods, using energy for machinery and heating and cooling, and generating all types of hazardous and non-hazardous waste. Determining the "environmental footprint" of a given item or operation can be extended in the extreme to consider the entire process from resource extraction (e.g., cotton farming and mineral mining for dyes) to resource disposal or reuse – something commonly called a "life cycle analysis." A life cycle analysis is well beyond the scope of this Guidebook and likely beyond the interest and control of the garment factories in Saipan. Rather, what is of use and interest is how to quantify a garment factory's environmental footprint and compare it against similar factories.

Quantitative measures of the environmental impacts of a garment factory are based on actual operating data provided by nine garment factories in Saipan between May 2004 and May 2005.

Each garment has its own unique environmental footprint. This section provides quantitative measures of the environmental impacts of a garment factory based on actual operating data between May 2004 and May 2005 from nine garment factories in Saipan. Because garment factories in Saipan only cut and sew bulk fabrics to create garments, this data excludes the environmental impacts associated with textile manufacturing. While not insignificant, the environmental impacts associated with cutting and sewing are less substantial than those resulting from fabrication and dyeing processes. Similar data provided from factories in India, Bangladesh, and Sri Lanka that produce the entire garment show the majority of environmental impacts occur during the textile manufacturing processes. These steps use significantly more energy, water, raw materials and hazardous materials, and generate more waste that the garment manufacturing steps.

The following sections quantify the environmental footprint of manufacturing a garment in four areas: energy use, water use, solid waste generation, and hazardous chemical use. Before delving into the specifics of each of these areas, it is important to appreciate the growing importance of tracking such environmental metrics, as well as having a conceptual understanding of what specific processes contribute to each of the four focus areas.

3.1 Global Reporting Initiative Environmental Performance Indicators

As shown in Figure 3-1, the four focus areas in this Guidebook align with some of the environmental performance indicators defined by the Global Reporting Initiative (GRI, www.globalreporting.org), an independent institution whose mission is to develop and disseminate globally applicable Sustainability Reporting Guidelines. GRI's performance indicators provide a means for measuring and reporting environmental footprint, and along with similar auditing and reporting schemes provide a *recognizable, comparable, measuring tool*. Given the shifting competitive landscape facing garment factories and the structurally higher labor costs in Saipan, it will be increasingly important to find ways to differentiate performance from other similar factories around the globe. GRI-based sustainability reporting is one way to do just that.

FIGURE 3-1 | A CROSSWALK BETWEEN THE GREEN GARMENTS PROJECT AND GRI SUSTAINABILITY REPORTING

Green Garments Focus Area	GRI Environmental Performance Indicator
Energy Use	EN_3. Direct energy use segmented by primary source.
Water Use	EN_5. Total water use.
Solid Waste Generation	EN_{11}. Total amount of waste by type and destination.
Hazardous Chemical Use	EN_1. Total material use other than water, by type.

The GRI guidelines are for voluntary use by organizations for reporting on the economic, environmental, and social dimensions of their activities, products, and services. The GRI Sustainability Reporting Guidelines are supported by sector supplements that identify issues specific to sectors that are not directly addressed in the core Guidelines for sustainability reporting. GRI has launched a sector supplement project for the apparel and footwear sector (www.globalreporting.org/guidelines/sectors/apparel.asp) to provide reporting guidance based on the GRI Sustainability Reporting Guidelines for apparel and footwear companies. The apparel and footwear sector supplement is expected in mid-2006.

Garment retailers have grown more dependent on suppliers operating thousands of miles away and are increasingly interested in making sure those suppliers operate responsibly. Retailers' sustainability reporting will require suppliers to provide more and more detailed environmental performance information.

An increasing number of retail companies – such as Gap, Nike, and adidas-Salomon – have begun annual GRI-based sustainability reporting. Therefore, an understanding of these reports can provide insight to what information retail customers are interested in knowing of their supply chain.

3.2 Garment Manufacturing Environmental Focus Areas

As discussed in Section 2, the Green Garments Project assessed all aspects of a garment factory's operations. After reviewing data provided in the preliminary surveys and discussing environmental concerns with factory managers, the Green Garments Project considered several factors to prioritize environmental focus areas, including:

- Environmental Impact
- Effect on Employees and Residents
- Effect on Local Community

As a result, energy use, water use, solid waste generation, and hazardous chemical use emerged as the areas with the overall greatest impact on the environment, employees, and local community. While these do not represent all of the environmental impacts associated with garment manufacturing, these four focus areas enable the Green Garments Project to provide recommendations of readily available BMPs offering the most potential savings and environmental impact.

The environmental footprint of the Saipan garment factories can also divided between activities associated with (a) the manufacturing process, and (b) the on-site dormitories. Figures 3-2 and 3-3 identify each environmental focus area associated with each activity for manufacturing and dormitories, respectively. Making this distinction makes it easier to draw comparisons between the environmental impacts of garment factories in Saipan versus other areas in the world and develop recommendation appropriate for each category. As it turns out, the environmental impact of dormitories is a smaller, but still significant component of the typical overall garment factory in terms of water and energy use. And because factories have control over the cost and environmental impact of onsite dormitories, this Guidebook provides data and recommendations for this facet of the garment factories' operation.

FIGURE 3-2 | ENVIRONMENTAL ASPECTS OF GARMENT MANUFACTURING PROCESSES

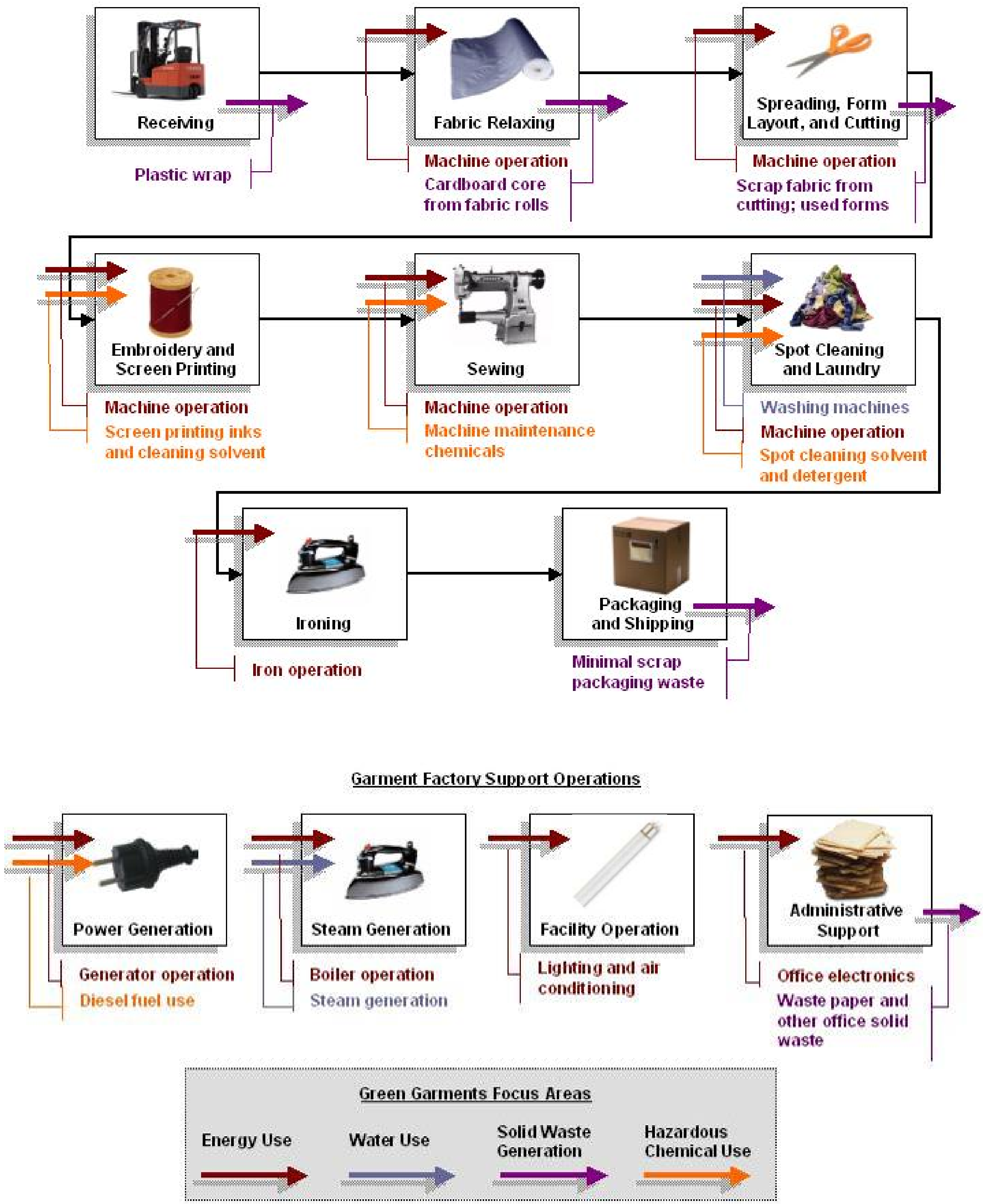
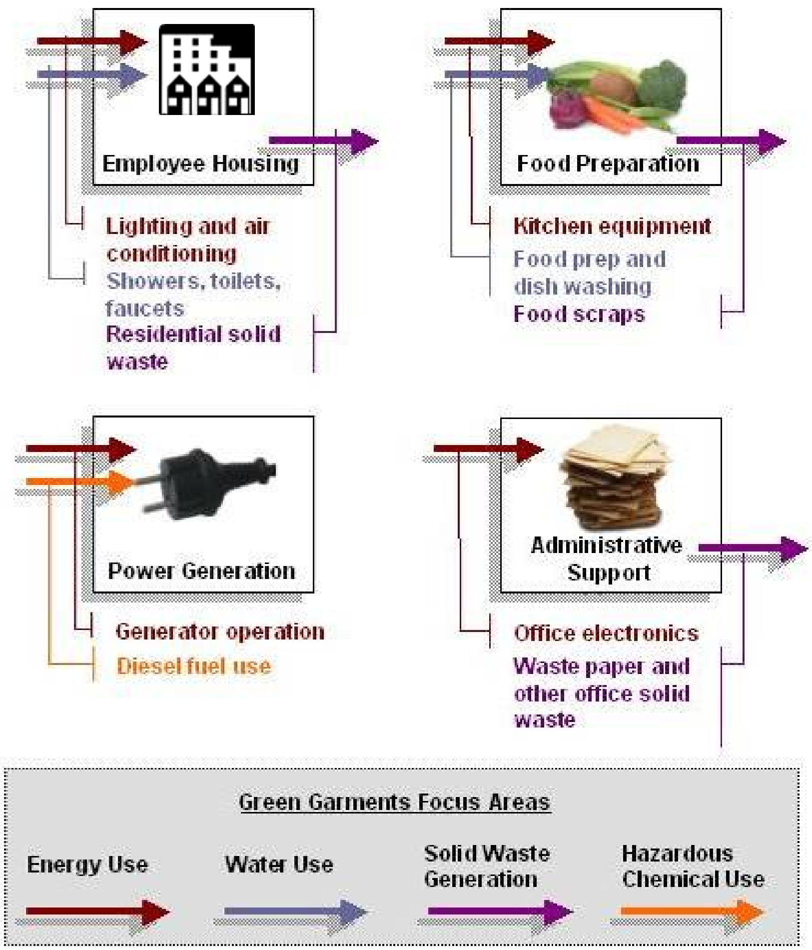


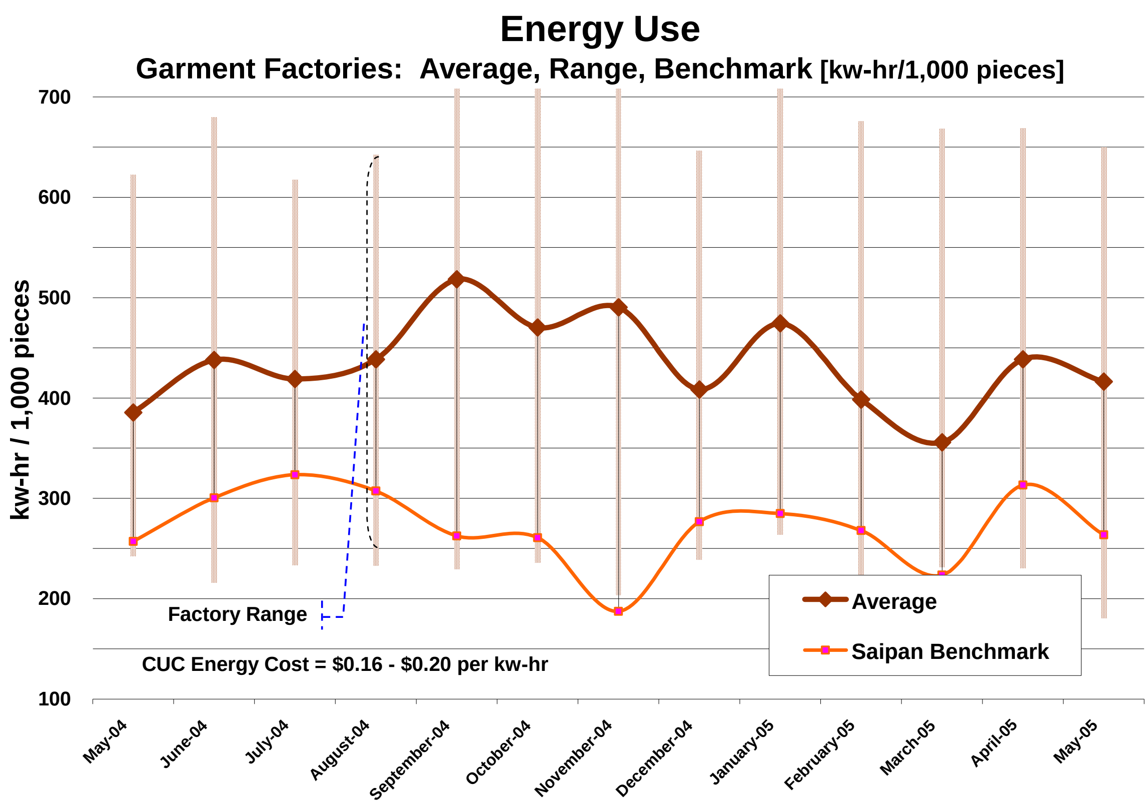
FIGURE 3-3 | ENVIRONMENTAL ASPECTS OF GARMENT FACTORY DORMITORIES



3.3 Energy Use

Saipan garment factories use energy from either the Commonwealth Utility Corporation (CUC) or from onsite diesel generators. Photovoltaic cells or other forms of alternative energy sources are not in use at any of the factories visited. Energy data provided by the garment factories were separated into energy consumed for the manufacturing process and for dormitories. Figure 3-4 shows energy use per 1,000 garments produced; Figure 3-5 shows energy use per dormitory resident, per day.

FIGURE 3-4 | GARMENT FACTORY ENERGY USE



kw-hr/1,000 pieces

	Average+	Benchmark
Saipan	**435#**	**271***
India	388	310
Bangladesh	453	362
Sri Lanka	362	336

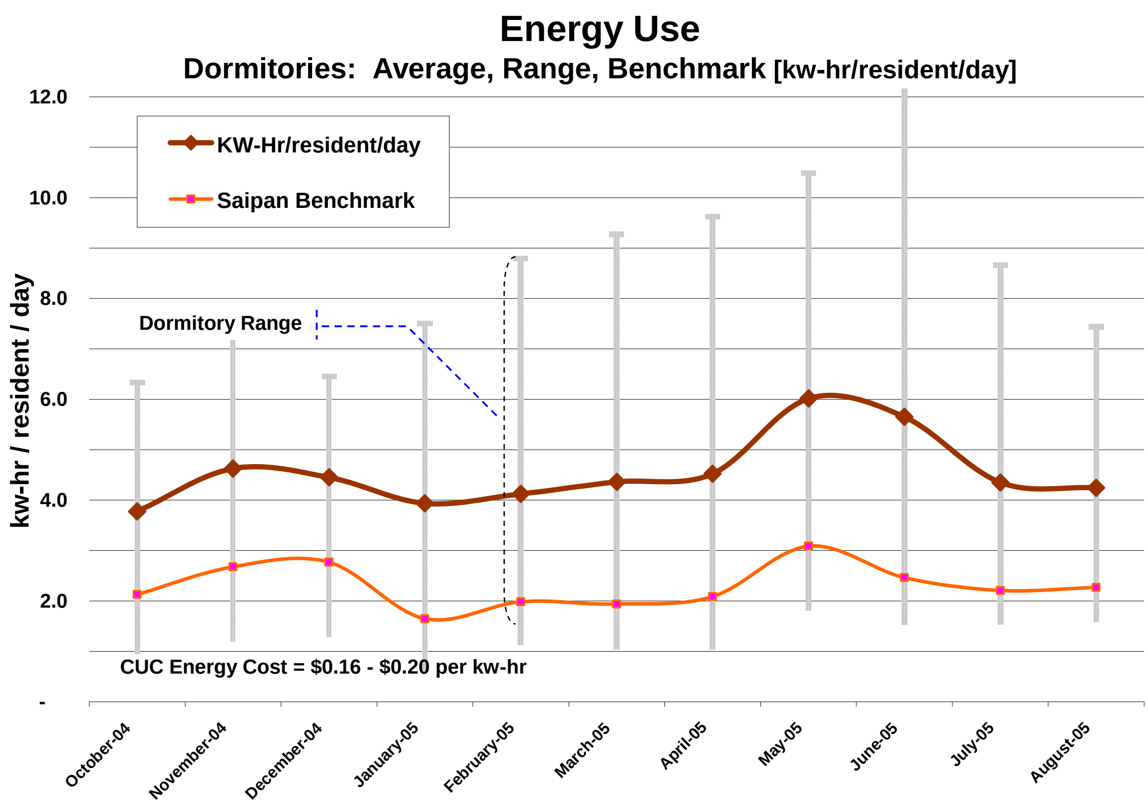
Notes:

+ Data from all countries includes fabric cutting, sewing, trimming, quality control, ironing, and packing.

For Saipan factories providing combined energy data (for both manufacturing and dormitories), dormitory energy use was subtracted from the combined data using estimates based on the number of residents at the factory times the average energy use per resident at all other factories reporting dormitory-only data.

* Benchmark = Average – (0.75) (standard deviation)

FIGURE 3-5 | DORMITORY ENERGY USE



kw-hr/resident/day

	Average	Benchmark
Saipan (garment factory residents)	**4.55**#	**2.99**#
U.S. (general population)	**35.1***	**--**
Hawaii (general population)	**21.9***	**--**

Notes:

Based on factories reporting dormitory-only data.

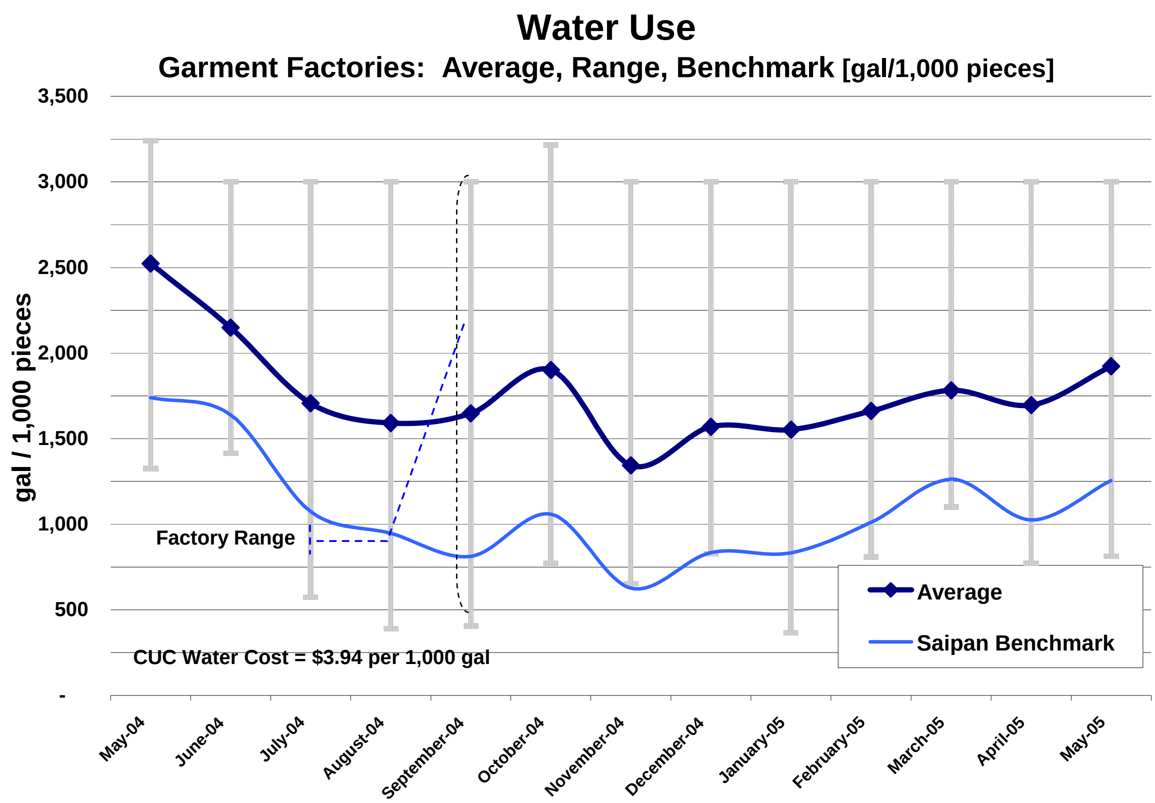
+ Benchmark = Average – (0.75) (standard deviation)

* California Energy Commission, 2001, www.energy.ca.gov/electricity/us_percapita_electricity.html

3.4 Water Use

Saipan garment factories use three water sources: CUC-provided water, groundwater from onsite wells, and rainwater from onsite collection systems. The typical scenario found at the factories was that the manufacturing floor used a combination of CUC-provided water and groundwater for laundry, boiler operation, and air conditioning equipment, and dormitories used rainwater (typically treated using reverse osmosis systems) for personal hygiene and food preparation. Each gallon of treated rainwater used at a garment factory reduces the groundwater pumped from wells or purchased from CUC. Figure 3-6 shows water use per 1,000 garments produced; Figure 3-7 shows water use/resident/day.

FIGURE 3-6 | GARMENT FACTORY WATER USE



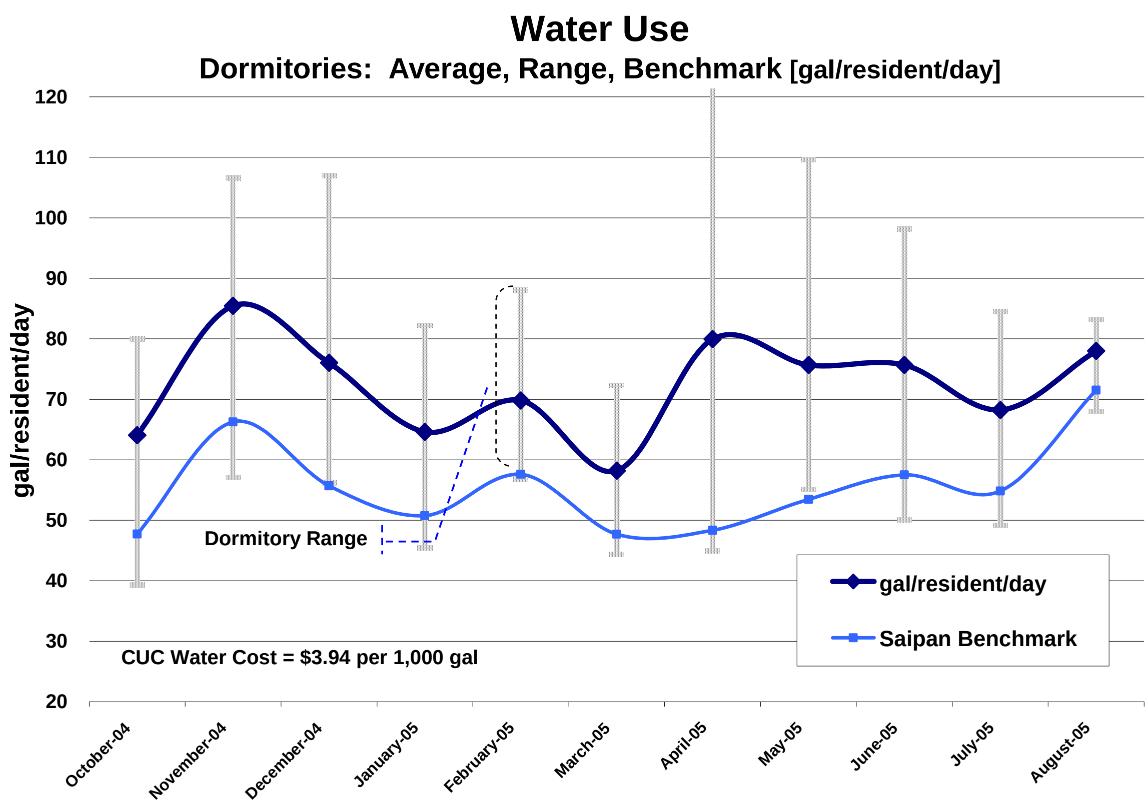
	gallons/1,000 pieces	
	Average	**Benchmark**
Saipan	1,773+	1,086#

Notes:

+ For Saipan factories providing combined energy data (for both manufacturing and dormitories), dormitory energy use was subtracted from the combined data using estimates based on the number of residents at the factory times the average energy use per resident at all other factories reporting dormitory-only data.

Benchmark = Average – (0.75) (standard deviation)

FIGURE 3-7 | DORMITORY WATER USE



	gallons/resident/day	
	Average	**Benchmark**
Saipan (garment factory resident)	**72.3#**	**55.6+**
U.S. (general population)	**74***	**52***

Notes:

\# Based on factories reporting dormitory-only data.

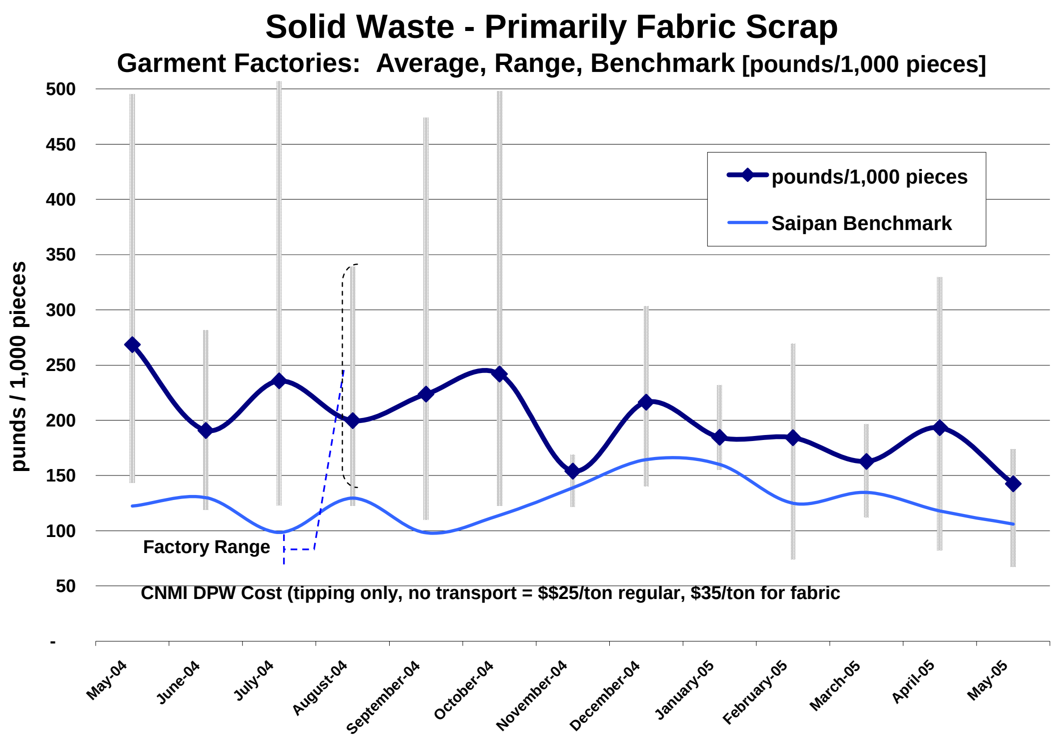
\+ Benchmark = Average – (0.75) (standard deviation)

* Average is for U.S. residential indoor water use; benchmark is with water efficient fixtures. American Waterworks Association, www.awwa.org/Advocacy/pressroom/statswp5.cfm

3.5 Solid Waste Generation

By far the largest component of solid waste generation from the garment factories is scrap fabric. In fact, scrap fabric is the largest component of Saipan's entire solid waste stream comprising up to 25 percent by weight. CNMI DPW operates a recycling program that accepts numerous recyclables including scrap fabric for no charge (see Section 6.0 for more detail). Other solid wastes and recyclables generated in much smaller amounts from garment factories include cardboard and plastic packaging materials, and organic and household wastes from the dormitories. Most of the factories pay a garbage contractor to remove solid waste and recyclables for a fixed monthly fee and as a result, reliable and consistent records of the amount of solid waste generated are difficult to calculate in the same manner as energy and water. But, combining fabric scrap and production data provided by several factories with observations during onsite visits, estimates for solid waste generation in the garment factories are provided in Figure 3-8.

FIGURE 3-7 | GARMENT FACTORY SOLID WASTE GENERATION



	lbs/1,000 pieces	
	Average	**Benchmark**
Saipan	**200**	**126**
India	165*	
Bangladesh	193*	**Not Available**
Sri Lanka	187*	

Notes:

\# Benchmark = Average – (0.75) (standard deviation)

* Data includes additional solid waste from textile manufacturing wastewater treatment sludge; nonetheless, solid waste is primarily fabric scrap.

3.6 Hazardous Chemical Use

The only hazardous chemicals used in any appreciable amounts in the garment factories are the solvents used for spot cleaning (see Section 7.0 for recommendations). All of the factories used a one or more of the following chlorinated solvents: tetrachoroethylene (TCE), perchloroethylene (PERC), and methylene chloride. Though the chemicals were generally very well controlled using ventilation systems and personal protective equipment, each of the chemicals is toxic to humans in significant and varying degrees.

Garment workers manually applied the solvent to stained and spotted garments using a variety of spray guns and nozzles. Data collected in pre-visit questionnaires and during site visits varied widely. Garment factory staff stated the inconsistency was largely due to the variability in the occurrence of spots and the customers' quality control requirements. As a result, it is difficult to provide average and benchmark amounts based on the data collected. The most consistently stated usage rate was the equivalent of 1 to 2 13-ounce aerosol cans of spot cleaner per employee per shift.

The imprecise and anecdotal nature of that figure implies that the factories should begin better monitoring and controlling the use of these toxic and hazardous chemicals to identify overuse and inefficiencies.

FIGURE 3-8 | GARMENT FACTORY CHLORINATED SOLVENT USE

	gallons/1,000 pieces	
	Average	**Benchmark**
Saipan	**Not Available**	

4.0 FOCUS AREA 1: ENERGY USE

The impacts associated with energy use, while not the most obvious, are probably the most significant environmental impacts resulting from garment factory operations. CUC, the local public power provider, relies wholly on a diesel-fueled power plant to provide electricity to the island. Due to an island-wide power supply shortage and long waits following typhoons for complete power restoration, Saipan garment manufacturers typically opt to also have an onsite diesel generator for back-up power[3].

Energy costs for Saipan garment manufacturers ranged between $20,000 and $120,000 per month; therefore, reducing energy use by 30% could save from $6,000 to $36,000 per month.

Diesel emissions contain a mixture of compounds, including carbon monoxide (CO), nitrogen oxides (NO_x) and diesel particulate matter that are harmful to human health and to the environment. To reduce these emissions, Saipan garment manufacturers should:

- **Reduce overall energy consumption** through conservation and efficiency improvements, reducing both diesel emissions and monthly facility energy costs.
- **Minimize use of on-site diesel generators**, which generally emit more pollutants per kilowatt-hour of energy produced than centrally provided diesel power plants.

This section describes practical opportunities for garment factories to reduce their energy consumption through efficiency improvements and low-cost system upgrades. This section uses the EPA Energy Star program tools and resources as a starting point, including: a prescriptive approach for determining energy requirements, conducting an energy audit, and choosing low-cost, high-impact energy reduction projects.

Figure 4-1 provides an overview of the BMPs discussed in this section. For each BMP, a quantitative score is provided based on a scale of 1 (low) to 5 (high) for capital requirements and potential energy-saving impact. The priority score is calculated as follows:

Priority Score = (energy-saving score) – (capital requirements score)

The resulting priority score can be interpreted as follows for the recommended BMPs:

- **Positive Priority Score.** Indicates that the recommended BMP will reduce energy use and provides a short payback period on capital investments. *The higher the priority score, the greater the return on investment.*
- **Zero Priority Score.** Indicates the BMP has balanced costs and benefits; both scores could be high or low. *These BMPs should be additionally considered for capital available when compared to other potential BMPs.*

---

3 Operation of onsite diesel generators requires garment manufacturers to comply with applicable storage tank, spill prevention, and air permitting regulations.

- **Negative Priority Score.** Indicates the recommended BMP will reduce energy use, but the payback period on capital investments is longer than BMPs will higher priority scores. *The lower the prioritization ranking, the longer it will take to recoup capital investments.*

FIGURE 4-1 | ENERGY USE BEST MANAGEMENT PRACTICES

Best Management Practice	Energy Savings	Capital Requirements	Priority Score*
Collect baseline energy use data and conduct an energy audit.	3	1	2
Optimize equipment use based on changes in production.	2	1	1
Determine appropriate task-based lighting levels for each area of the facility.	2	1	1
Optimize existing lighting systems by adjusting lighting proximity and using task lighting.	3	1	2
Develop written procedures and implement a scheduled, facility-wide lighting system maintenance program.	3	1	2
Implement a strategic relamping program.	2	1	1
Use automated controlled lighting systems.	3	2	1
Upgrade from magnetic to electronic or hybrid ballasts.	4	2	2
Upgrade fluorescent lighting to T8 or T5 lamps.	4	2	2
Use compact fluorescent lights in place of incandescent bulbs.	2	1	1

1	2	3	4	5
Low		Moderate		High

* Priority Score = (Energy Saving Score) – (Capital Requirements Score)

FIGURE 4-1 | ENERGY USE BEST MANAGEMENT PRACTICES
(continued)

Best Management Practice	Energy Savings	Capital Requirements	Priority Score*
Upgrade exit signs to use light-emitting diode (LED) lights in places of incandescent bulbs.	3	1	2
Develop a written policy to consider energy-efficiency when purchasing new equipment.	2	1	1
Install an evaporative cooling system.	5	3	2
Develop a steam leak inspection schedule for boiler operations.	3	1	2

1	2	3	4	5
Low		Moderate		High

* Priority Score = (Energy Saving Score) – (Capital Requirements Score)

4.1 EPA Energy Star Program

Energy Star is a U.S. Federal government sponsored program helping businesses and individuals protect the environment through superior energy efficiency. EPA's Energy Star partnership for businesses offers a proven energy management strategy that helps measure current energy performance, set goals, track savings, and reward improvements. The Energy Star Upgrade Manual for Buildings[4] provides an integrated approach for determining facility-specific opportunities to maximize energy and cost savings.

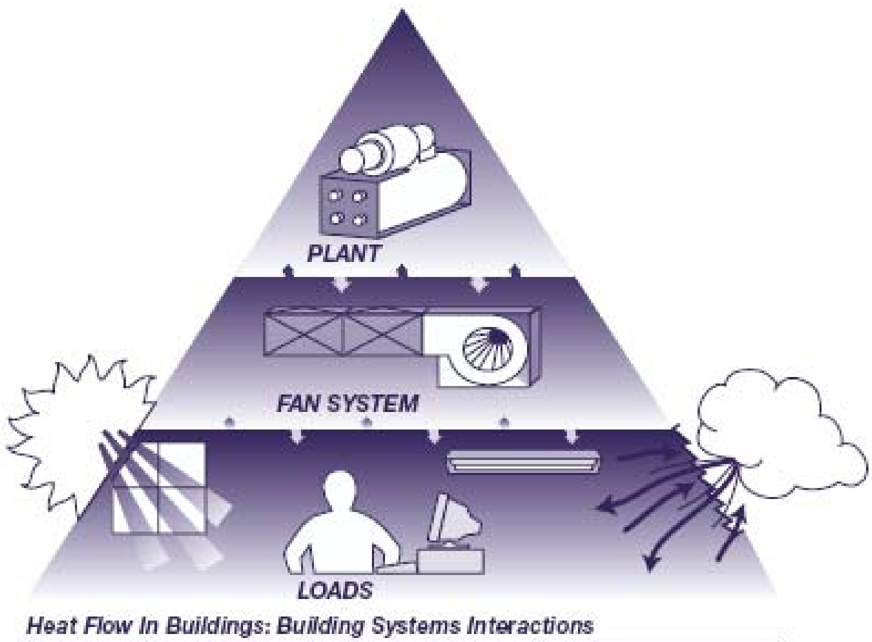
Fundamental to the Energy Star approach is a conceptual understanding of what factors directly influence energy demands and how they can be changed to improve energy performance. Figure 4-2 illustrates how heat and energy flow in a building and the resulting impacts on a building's heating, ventilation, and cooling (HVAC) system. In garment factories, heat is given off by lights, people, sewing machines, and office equipment—heat sources collectively categorized as supplemental loads. Solar radiation and hot outside air—entering through windows, doors, and open warehouse garages—also introduce heat that increase cooling needs. Knowing the relationships between these factors and their relative impacts on energy use can help your factory make strategic decisions about what energy saving opportunities exist. Ultimately, garment factories should strive to:

4 Energy Star Upgrade Manual for Buildings, December 2004. Online at: www.energystar.gov/ia/business/BUM.pdf

1. Maintain plant equipment, including boilers and air conditioners, to ensure they operate efficiently and optimize fan systems.
2. Minimize the introduction of excess heat from controllable sources, such as lighting, windows, and other supplemental loads.

FIGURE 4-2 | ENERGY USE BEST MANAGEMENT PRACTICES

from the Energy Star Upgrade Manual for Buildings, December 2004



Heating, cooling, and electrical loads need to be overcome by the HVAC equipment is shown above. Arrows indicate heat flow pathways. Reducing heating, cooling, and electrical loads reduces the demand on HVAC equipment, thus saving energy.

Figure 4-3 provides an overview of the Energy Star approach to planning projects that maximize energy savings and compares it to the sector-specific resources provided in this document.

FIGURE 4-3 | ENERGY STAR STRATEGIC APPROACH AND GREEN GARMENTS RESOURCES

from the Energy Star Upgrade Manual for Buildings, December 2004

Energy Star Strategic Approach	Green Garments Resources
1. Recommissioning Periodically examine building equipment, systems, and maintenance procedures as compared to design intent and current operational needs.	Section 4.2 provides resources for conducting an energy audit to determine what processes are most energy-intensive. Note: An energy audit is not recommissioning.
2. Lighting Install energy-efficient lighting systems and controls that improve light quality and reduce heat gain.	Section 4.3 discusses opportunities to minimize energy demands by: ▪ maximizing efficiency of existing lighting ▪ implementing low-cost lighting upgrades.
3. Supplemental Load Reductions Purchase Energy Star labeled office equipment, install window films and add insulation or reflective roof coating to reduce energy consumption of supplemental load sources.	Section 4.4 presents garment sector-specific considerations for reducing the energy demand of supplemental loads.
4. Fan Systems Upgrades Properly size fan systems, adding variable speed drives, and converting to a variable-air-volume system.	Not included in Green Garments Guidebook.
5. Heating And Cooling System Upgrades Replace chlorofluorocarbon chillers, retrofit or install energy-efficient models to meet the building's reduced cooling loads, upgrade boilers and other central plant systems to energy-efficient standards.	Section 4.5 provides information on energy-efficient cooling systems currently used by some Saipan garment manufacturers. Section 4.6 provides information on improving the efficiency of boilers.

4.2 Conducting an Energy Audit

4.2.1 Determine Where You Are

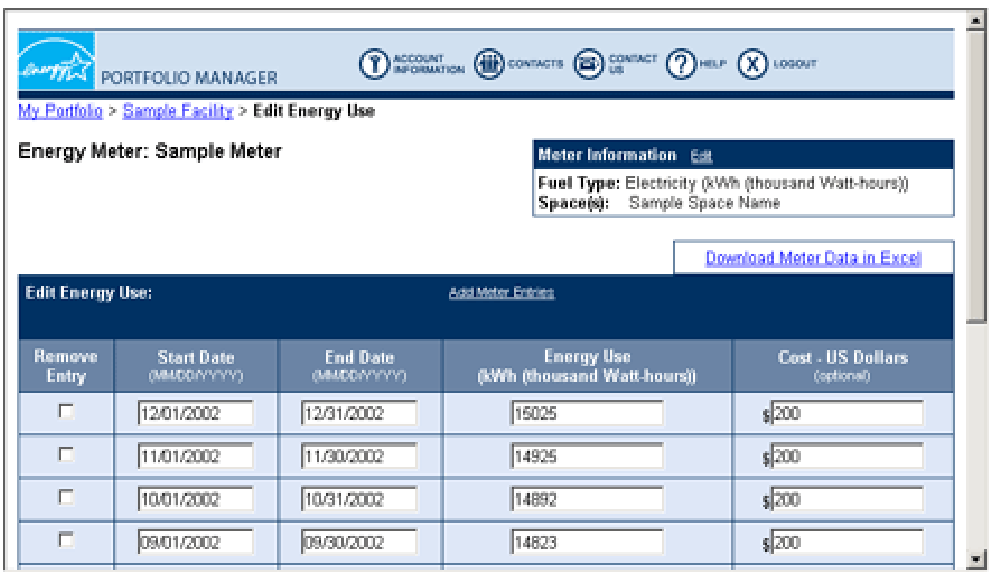
Start by getting the numbers! Before pursuing energy efficiency projects, it is important to first determine baseline energy use. Like the energy data presented in Section 3.3, baseline data will provide insight to energy-use trends and enable more accurate cost-benefit analysis of specific projects. Energy data, including both kilowatt hours used and cost, is easily collected from monthly CUC utility bills. Garment factories should also account for energy use from on-site diesel generators by converting the diesel usage to a common energy unit such as kilowatt-hours, joules, or British Thermal Units (BTU). The conversion factors required depend entirely on the type of fuel used, and the age, maintenance, design, and operation among other factors of the generator.

Once baseline energy data is compiled, a more comprehensive energy audit can be conducted to determine which processes use the most energy. The audit can be completed using factory engineers or an energy consultant. The initial audit may indicate a need to track the factory's total energy use in more detail by installing additional energy meters. Just collecting and analyzing the energy use data collected during an energy audit will often uncover energy inefficiencies and make clear what steps need to be taken.

4.2.2 Energy Management Software

While there are numerous energy management software packages available commercially, Energy Star offers a free "online profile manager" to assist in rating buildings performance on a scale of 1 to 100. The scale provides scores relative to similar buildings in the U.S. and uses EPA's national energy performance rating system. The rating system accounts for the impacts of year-to-year weather variations, as well as building size, location, and several operating characteristics. Figure 4-4 shows just a portion of the Energy Star online portfolio manager approach to cataloguing energy consumption.

FIGURE 4-4 | ENERGY STAR PORTFOLIO MANAGER
from the Energy Star Portfolio Manager website

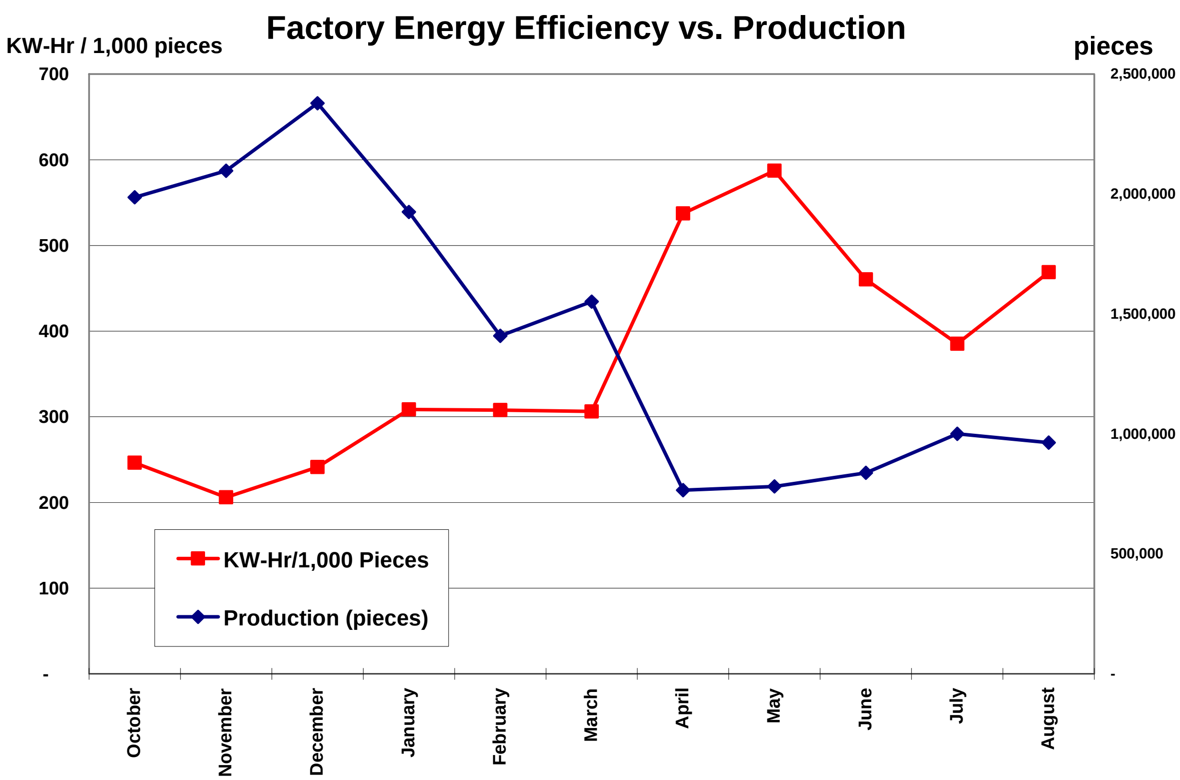


4.2.3 Production and Its Effect on Energy Efficiency

Often overlooked in an evaluation of energy in a manufacturing setting is how the level of production affects efficiency. Simply stated, fully utilized manufacturing equipment uses resources, including energy, more efficiently. The effect can be dramatic and it points toward taking steps to avoid waste. Consider the data in Figure 4-5, showing energy use normalized for production on one Y-axis and overall production on a second Y-axis. In this circumstance, no material changes in equipment or process changed at the factory; only production did, decreasing by about 50 percent. Why did the drop in production correspond to a drop in energy efficiency? And what steps might be taken to minimize the efficiency loss? Here are some possible reasons and corresponding suggestions:

- **Evaluate All Equipment:** When production areas are shutdown, sometimes supporting systems are not turned off or incompletely turned off at the same time. *Investigate whether the use of supporting systems to the main manufacturing equipment have been or can be also reduced or eliminated. Consider lighting, compressed air, ventilation, boilers, etc.*
- **Equipment Startup:** Many types of equipment require a startup time to reach be operational or to be a peak efficiency. *Evaluate the types of equipment you have and if possible, schedule work to minimize the frequency of shutdown/startup cycles.*
- **Shutdown:** Staff sometimes react to large changes in production by overreacting or under reacting. When production spikes up, too much equipment is initially put into service and when production dips precipitously, equipment is taken out of service too slowly or in an inefficient way leaving multiple pieces of equipment underutilized. *Consider shutting down an entire production areas or specific pieces of equipment to better respond to production changes. This may require a shift in staff and production from line to line or a close evaluation of production levels*
- **Work Phasing:** Especially during a downturn in production, several areas of production can be working at less than optimal levels. *Consider shifting or phasing work schedules so that equipment is used more efficiently and areas can be more easily shutdown.*

FIGURE 4-5 | PRODUCTION AND ITS EFFECT ON ENERGY EFFICIENCY



4.3 Lighting

Lighting is one of the biggest energy consumers in a garment factory. The reason for evaluating lighting is twofold: direct energy use and waste heat generation. Most people are familiar with lighting wattage and the types of progressively more efficient lighting, but overlook the same lights as a primary source of heat gain and waste heat that in turn adds to the loading on cooling systems. Using a simplified approach to implementing a basic lighting efficiency strategy, illustrated in Figure 4-6, the following sections describe opportunities to reduce energy use from lighting in garment factories.

FIGURE 4-6 | LIGHTING EFFICIENCY IMPLEMENTATION STRATEGY

1. Determine Appropriate Lighting Levels
2. Optimize Existing Lighting Systems
3. Upgrade Using Energy Efficient Lighting

4.3.1 Determining and Meeting Appropriate Lighting Levels

Before considering potential energy efficiency projects, garment factories should step back and objectively evaluate lighting needs throughout the facility. Are there areas that have excess lighting? Should some areas have more lighting to increase worker productivity? To answer these questions, garment factories must first determine the specific lighting needs of the workers dependent on the specific tasks completed in each area of the facility.

The Illuminating Engineering Society of North America (IESNA) has developed guidelines to select appropriate illuminance (light) levels for hundreds of indoor and outdoor activities (some of which are listed in Figure 4-7). The recommended lighting levels are based on a number of factors, and represent the level at which the average person can complete tasks without developing eyestrain. Garment factories can use the IESNA recommendations as a guideline for comparison with the levels found on the shop floor. Once deficiencies in the current lighting scheme are identified, then lighting efficiency projects can be implemented accordingly.

4.3.2 Optimizing Existing Lighting Systems

Improving lighting efficiency does not always require changing or purchasing new fixtures and lights. In some cases, minor modifications to existing systems or improved maintenance practices can improve the lighting levels and quality.

- **Adjust lighting proximity.** In areas of garment factories with high ceilings, such as warehouses and garment cutting areas, excess lighting may be installed to ensure an adequate amount of light reaches working surfaces. Garment factories should evaluate the feasibility of lowering ceiling-mounted ballasts and lighting, decreasing the overall distance from lighting sources to working areas. This simple modification can often be completed using existing equipment and will (1) better utilize installed lighting, and (2) require fewer lamps to light the working space.

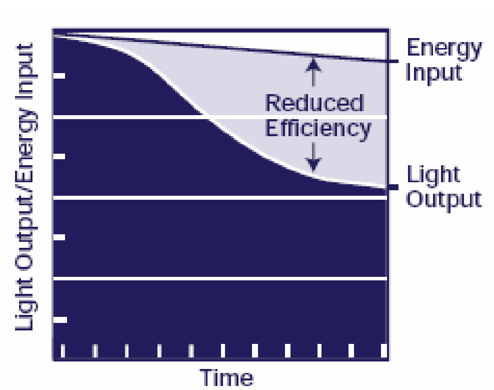
FIGURE 4-7 | IESNA RECOMMENDED LIGHT LEVELS (IN FOOTCANDLES)
From the IESNA Lighting Handbook

	foot-candles
Average Reading and Writing	50
Offices with Computer Screens	
▪ Task Lighting	25
▪ Ambient Lighting	25
Hallways	10
Stockroom Storage	30
Loading and Unloading	10
Parking Lots	0.8 – 3.6
Building Entrance	5

- **Use task lighting.** Are the right types of lights used for each area? There are three general categories of lighting in manufacturing settings: general/ambient, task, and indirect. Employing each appropriately is important in energy efficiency, worker productivity, and worker safety and comfort. In most cases in the garment factories, the main modification for better light design is to replace some of the general lighting with task lighting—in essence putting the available lighting exactly where it is needed and nowhere else thereby reducing the need for general lighting in common areas. For example, the addition of lower power task lights for each sewing station would reduce the amount of ceiling-mounted lighting and energy consumption in the sewing room.

- **Clean and maintain bulbs.** Often attention is only given to lighting systems when a lamp fails; however, regular cleaning and maintenance can enhance the overall performance of a lamp and lighting system. For example, the amount of light emitted from long-life bulbs (see Figure 4-8) will diminish over time not only because of age, but also because of dirt accumulation on fixtures, lamps, and room surfaces. Garment factories should implement a scheduled maintenance program to ensure that fixtures are routinely cleaned and properly maintained. At a minimum, Energy Star indicates that the following procedures should be documented and made available to all building management and maintenance staff to ensure lighting systems are properly maintained:
    - Fixture cleaning and relamping schedule with service tracking log.
    - Procedures for relamping, reballasting, and cleaning fixtures.
    - Procedures for proper lamp and ballast disposal.

FIGURE 4-8 | LIGHTING EFFICIENCY LOSS
from the Energy Star Upgrade Manual for Buildings, December 2004



- **Use strategic relamping.** Energy Star encourages group relamping when lamps reach 70 percent of their projected life span, the point at which lamps performance begins to decrease in efficiency and output. Although lamps are replaced before the end of their useful life, the money and energy spent during the last months of the lamp would be better used on a replacement lamp. Group relamping also allows bulk purchases, decreases the amount of time spent replacing each lamp, and minimizes lighting service requests, ultimately reducing the overall lighting maintenance budget.

- **Install automatic control systems.** In some cases, automatic control devices may be installed to improve lighting efficiency. These systems turn lights on and off based on a fixed schedule, area occupancy, or lighting levels. Since most areas of garment factories are continually occupied, application of this technology to reduce energy consumption is limited to those areas that are used intermittently.

4.3.3 Upgrading with Energy-Efficient Lighting

Commercial buildings typically use two types of lighting: fluorescent and high-intensity discharge (HID) lighting. Fluorescent lighting is typically used indoors for general diffuse lighting, whereas HID lighting is best used outdoors and in large areas requiring high levels of light. Both of these lamp types require a ballast to start up, control power, and control light quality of the lamp. Other types of lighting exist that may offer more appropriate lighting as needed to perform specific work tasks. Figure 4-9 compares the characteristics of several lamp types.

FIGURE 4-9 | LAMP CHARACTERISTICS

from the Energy Star Upgrade Manual for Buildings, December 2004

	Standard Incandescent	Full-Size Fluorescent	Mercury Vapor	Metal Halide	High-Pressure Sodium
Wattages	3 – 1,500	4 - 215	40 – 1,250	32 – 2,000	35 – 1,000
System Efficacy (lumen/watt)	4 - 24	49 – 89	19 – 43	38 – 86	22 - 115
Average Rated Life (hours)	450 – 2,000	7,500 – 24,000	24,000+	6,000 – 20,000	16,000 – 24,000
Color Rendering Index	98+	49 – 85	15 – 50	65 – 70	22 – 85
Life Cycle Cost	High	Low	Moderate	Moderate	Low
Source Options	Point	Diffuse	Point	Point	Point
Start-to-Full Brightness	Immediate	0 – 5 seconds	3 – 9 minutes	3 – 5 minutes	3 – 4 minutes
Restrike Time	Immediate	Immediate	10 – 20 minutes	4 – 20 minutes	1 minute
Lumen Maintenance	Good / Excellent	Fair / Excellent	Poor / Fair	Good	Good / Excellent

Energy efficiency improvements can be achieved by upgrading both the ballast and the type of lamp. To assist businesses in performing a full analysis of potential lighting upgrades, Energy Star developed “ProjectKalc,” a software program that provides a comprehensive energy and economic analysis of upgrades involving controls, relamping, and delamping. The ProjectKalc software includes a user-modifiable database of costs, labor time, and performance for over 8,000 common hardware applications (see additional resources in

Section 10). The following opportunities are most applicable to garment manufacturing facilities:

- **Upgrade Ballast.** There are two common types of ballasts: magnetic and electronic. Magnetic ballasts are the most common, but the least efficient ballasts available. Electronic ballasts reduce wattage by 10 to 15 percent, operate at lower temperatures, and last longer than standard magnetic ballasts. In addition, electronic ballasts offer reduced flicker, lower fixture weight, less noise, and a longer life than magnetic ballasts. Hybrid ballasts, which combine features of magnetic and electronic ballasts, are also available. These ballasts offer the same efficiency benefits as electronic ballasts, but they cannot power more than three lamps.

- **Install Energy-Efficient Fluorescent Lamps.** The most efficient fluorescent lamp available is the T5 lamp. T5 lamps perform better in higher room temperatures and have lower system wattage. However, T5 lamps require electronic ballasts and are not meant to directly replace other types of fluorescent lighting.

  Currently, the best combination of lighting is either the T5 or T8 lamp with an electronic ballast. T10 and T12 lamps with their respective ballasts should be phased out and replaced with the more efficient lamps and electronic ballasts. System efficiency can be improved up to 30 percent when T8 lamps with electronic ballasts are used instead of T12 lamps with magnetic ballasts (see Figure 4-10).

- **Use Compact Fluorescent Lightbulbs (CFL).** CFLs are designed to be used as drop-in replacements for less efficient incandescent lighting. Although the cost per CFL is considerably more than incandescent laps, the CFL will pay for itself with an extended life, decreased energy use, and decreased maintenance costs. For example, CFLs typically need to be replaced every 10 years, whereas incandescent lamps are changed about every 10 to 12 months (depending on use). As discussed in Section 4.3.2, because of the long life of these bulbs, they require periodic cleaning to prevent dust and dirt from diminishing the amount of light emitted.

- **Upgrading Exit Sign Lighting.** The incandescent lamps used in exit sign lighting can be replaced with an energy-efficient light-emitting diode (LED) exit sign. LEDs have a longer life and use less energy than an incandescent or fluorescent light. Energy Star has an interactive calculator to estimate the energy savings associated with installing LED exit signs (see additional resources in Section 10).

FIGURE 4-10 | PERFORMANCE COMPARISON OF FLUORESCENT RETROFIT OPTIONS
from the Energy Star Upgrade Manual for Buildings, December 2004

	Case 1 T12 Lamps, magnetic ballasts	Case 2 "Energy Saving" T12 Lamps	Case 3 T8 Lamps, electronic ballasts	Case 4 Case 3 + reflector lens, 50% delamping	Case 5 Case 4 + occupancy sensors	Case 6 Case 5 + maintenance
Average Maintained Footcandles	28	25	30	27	27	27
Input Watts per Fixture	184	156.4	120	60	60	50
Total Power (kw)	2.206	1.877	1.440	0.720	0.720	0.600
Annual Energy Use (kw-hr)	8,832	7,507	5,760	2,880	1,800	1,500
COST						
Annual Energy Cost	$883.70	$750.74	$576.00	$288.00	$212.40	$177.00
Upgrade Cost	--	$312	$1,440	$1,620	$1,970	$1,970
SAVINGS						
Energy (%)	--	15%	35%	67%	80%	83%
Simple Payback (years)	--	2.4	4.7	2.7	2.9	2.8
Internal Rate of Return (10 year)	--	41%	17%	35%	32%	34%

4.4 Supplemental Load Reductions

Nearly everything that occurs in a garment factory generates heat, from cutting, sewing, and packaging garments to preparing worker meals. All of these things contribute to the "supplemental heat load" of the factory, adding demand to that caused by the climate on the ventilation systems and requiring additional cooling of the facilities. As a result, reducing the energy use of any one of these supplemental load contributors can provide further energy savings.

Unlike lighting projects, reducing supplemental load in garment factories is something that will most likely occur slowly over time as new equipment is purchased. The U.S. EPA Energy Star program provides lists of energy-efficient office equipment that can be referenced when new computers, fax machines, or photocopiers are purchased (see Section 10). More importantly, garment manufacturers can compare the energy-use ratings of cutting and sewing equipment when replacing old machines. For example, Brother Industries offers an electronic direct-drive lockstitch bar tacker that uses 30 percent less energy than competing models. Energy requirements should be considered when comparing the cost of new equipment. In many cases, the lower capital cost of less-efficient products will be offset by the higher cost of energy required to operate the product during its lifetime.

4.5 Heating and Cooling System Upgrades[5]

Saipan's tropical climate requires nearly year-round cooling accounting for more than 1/3 of garment factory electricity consumption. The constant demand for cooling and air conditioning warrants a detailed evaluation of the efficiency of these systems. Some Saipan garment factories use evaporative cooling, a particularly effective cooling system that requires up to 75 percent less energy than traditional air conditioning units.

Evaporative cooling differs from traditional air conditioning by evaporating water into the air stream to reduce temperature rather than using chlorofluorocarbons or other chemical refrigerants. Although evaporative cooling systems are most effective in dry climates where the air has a greater capacity to absorb evaporating water (see Figure 4-11), several large garment factories in Saipan have installed evaporative cooling systems with good cooling results and significant energy savings.

While the output of ordinary air conditioners is rated in British Thermal Units (BTU), evaporative coolers are rated by the cubic feet per minute (CFM) of air that the cooler can generate. To determine the size of evaporative cooling unit needed to serve a given factory area, calculate the total cubic feet of space that must be cooled and divide that number by 2. The quotient will give you the CFM rating for the proper-sized evaporative cooler. For example, to calculate the CFM of a sewing area of 7,000 square feet with 10-foot-high ceilings:

$$7{,}000 \times 10 = 70{,}000 \text{ cubic feet}$$

$$70{,}000 / 2 = 35{,}000 \text{ CFM needed}$$

[5] Section adapted from "Evaporative Cooling," California Energy Commission, Consumer Energy Center, www.consumerenergycenter.org/homeandwork/homes/inside/heatandcool/evaporative_coolers.html.

FIGURE 4-11 | TEMPERATURES DELIVERED BY EVAPORATIVE COOLERS
from the Arizona Almanac

% Relative Humidity

Air Temperature	2	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80
75	54	55	57	58	59	61	62	63	64	65	66	67	68	69	70	71	72
80	57	58	60	62	63	64	66	67	68	69	71	72	73	74	76	76	77
85	61	62	63	65	67	68	70	71	72	73	74	75	76	77	79	81	
90	64	65	67	69	70	72	74	76	77	78	79	81	82	83	84	86	
95	67	68	70	72	74	76	78	79	81	82	84	85	87				
100	69	71	73	76	78	80	82	83	85	87	88						
105	72	74	77	79	81	84	86	88	89								
110	75	77	80	83	85	87	90	92									
115	78	80	83	86	89	91	94										
120	81	83	86	90	93	95											
125	83	86	90	93	96												

Optimum conditions for Evaporative Coolers

Source: Ed Phillips, Arizona Almanac

Average Saipan temperature and humidity.

4.6 Boiler System Upgrades

As described in Section 2.2.2, garment manufacturers operate boilers to generate steam for ironing operations. In most facilities, the ironing boards are attached to a ventilation system that captures the heat emitted from the iron and exhausts it to the outside environment. The quantity and size of boilers located on site is proportional to the manufacturing operation.

At a minimum, all Saipan garment factories should repair steam leaks in boilers to minimize energy and water use.

Simple maintenance and more significant retrofitting projects can improve the efficiency of your boiler, saving both energy and water (see Section 5.2). The resources invested into improving the efficiency of your boiler should be dependent on its size; specifically, larger boiler operations deserve greater attention and offer greater potential energy savings. Figure 4-12 presents potential energy efficiency projects for boilers, ranging from low-cost fixes to more significant projects with long-term benefits. Regardless of boiler size, all garment factories should have written operation and maintenance procedures in place to check for steam and water leaks.

FIGURE 4-12 | ENERGY EFFICIENCY PROJECTS FOR BOILERS
from the U.S. Department of Energy, Energy Efficiency and Renewable Energy Office

	Project Description	Energy Savings	Cost
Short-Term	**Repair steam leaks** to minimize avoidable loss of steam.	1-2%	Moderate
Mid-Term	**Minimize vented steam** to minimize avoidable loss of steam.	2-5%	Low
	Implement effective steam trap maintenance program to promote efficient operation of end-use heat transfer equipment and reduce live steam in the condensate system.	2-5%	Low
Long-Term	**Use high-pressure condensate to make low-pressure steam** to exploit the available energy in the returning condensate.	1-3%	Moderate
	Utilize backpressure turbine instead of pressure-reducing or release valves to provide a more efficient method for reducing steam pressure.	5-8%	High
	Optimize condensate recovery to recover the thermal energy in the condensate and reduce the amount of makeup water needed.	1-3%	High

5.0 FOCUS AREA 2: WATER USE

Potable fresh water is perhaps the most precious commodity on Saipan. Though historically adequate, the groundwater resources in many parts of the island have been degraded to the point that they cannot be used for human consumption because of seawater intrusion, mixing of shallow and deeper groundwater aquifers, and contamination from industrial activities. Depending on operations, the factories use from 2 million gallons per year of water up to in the case of one factory, over 60 million gallons of water per year. In addition, the onsite dormitories water use of 72 gallons per resident per day, is very close to the overall U.S. average for residential use with not water efficiency of 74 gallons per capita. As described in Section 3.2, the garment factories generally obtain fresh water for manufacturing use from either on-site groundwater wells or on-site rainwater collection. In addition, most of the factories have installed rainwater collection systems to provide water for personal use, including bathrooms, bathing, and food preparation. The rainwater collection systems are a sustainable water resource and where appropriate, garment factories should expand these collection systems to save costs and preserve the island's scarce groundwater supply.

FIGURE 5-1 | WATER USE IN GARMENT FACTORIES

Water Use for Manufacturing Processes	
Laundry and Spot Cleaning	Washing machines and some steam cleaning for spot removal.
Embroidery and Screen Printing	Cleaning used screens and other screen printing equipment.
Water Use for Support Processes	
Employee Housing	Bathrooms—including toilets, faucets, and showers—and other personal uses.
Food Preparation	Cooking, food preparation, dishwashing, and cleaning.
Steam Generation	Boiler supply for steam generation to support ironing operations.

The processes that use the most water at the garment factories are not unique to the industry but, instead are related to ancillary activities; specifically laundering garments during garment manufacturing and personal hygiene (see Figure 5-1). Therefore, many of the water efficiency techniques and equipment from residential and business settings can be applied to the garment factories.

This section focuses on three of the most water-intensive processes: laundry, boiler operation, and restrooms in dormitories and the factory. Because these support operations exist in many other industry sectors, there are several proven BMPs to minimize the water use associated with each.

Figure 5-2 provides an overview of the BMPs discussed in this section. For each BMP, a quantitative score is provided based on a scale of 1 (low) to 5 (high) for capital requirements and potential water saving impact. The priority score is calculated as follows:

Priority Score = (water-saving score) – (capital requirements score)

The resulting priority score can be interpreted as follows for the recommended BMPs:

- **Positive Priority Score.** Indicates that the recommended BMP will reduce water use and provides a short payback period on capital investments. *The higher the priority score, the greater the return on investment.*
- **Zero Priority Score.** Indicates the BMP has balanced costs and benefits; both scores could be high or low. *These BMPs should be additionally considered for capital available when compared to other potential BMPs.*
- **Negative Priority Score.** Indicates the recommended BMP will reduce water use, but the payback period on capital investments is longer than BMPs will higher priority scores. *The lower the prioritization ranking, the longer it will take to recoup capital investments.*

FIGURE 5-2 | WATER USE BEST MANAGEMENT PRACTICES

Best Management Practice	Water Savings	Capital Requirements	Priority Score*
Develop and implement a preventive maintenance schedule for water leak identification and repair.	2	1	1
Maximize use of the most water efficient washers in laundry operations.	3	1	2
Install continuous batch washers in laundry operations.	4	5	-1
Retrofit washer-extractors to reuse final rinse water in laundry operations.	4	3	1
Recycle boiler condensate.	4	5	-1
Install water-efficient shower heads in dormitories.	3	1	2
Retrofit old toilets in dormitories and factory bathrooms to improve water efficiency.	3	1	2
Install low-flush toilets in dormitories and factory bathrooms to improve water efficiency.	4	2	2
Develop a water conservation outreach program for dormitories.	4	2	2

1	2	3	4	5
Low		Moderate		High

* Priority Score = (Energy Saving Score) – (Capital Requirements Score)

5.1 Laundry

As discussed in Section 2.1.6, some customers specify that certain garments are laundered during manufacture. Laundering is the largest water use operation in a garment factory. Laundry operations dedicated to washing new garments are not required to remove any heavy soil or stains, but rather address fabric shrinkage and stability issues. Therefore, washing the garments with mild detergent and cold water will typically suffice and no harsh chemicals or laundry additives are used. As a result, there is rarely environmental concern regarding wastewater content, and the focus centers around water use efficiency.

Several strategies for reducing the amount of water used in the laundering process—ranging from low- or no-cost procedural changes to complete overhauls in the laundering equipment used—are discussed in the sections below.

5.1.1 Procedural Water Conservation Strategies

Procedural water conservation strategies often can be implemented with the existing laundering operation. Low-cost BMPs can be implemented immediately without significantly changing current processes and, if actively maintained, can result in considerable water savings.

- **Implement Preventive Maintenance for Leak Identification and Repair.** While a small leak may not seem significant, over the course of a month or year the lost water can total thousands of gallons. An inspection schedule for routinely checking all water lines, pumps, and valves for leaking water can ensure prompt identification and repair. Figure 5-10 (included at the end of this section) provides an example leak identification checklist for use in your facility. A leak of 100 drops per minute wastes 350 gallons per month, and larger leaks can waste 2,000 to 2,700 gallons of water per month.[6] While sometimes leaks may signal problems with piping, often the solution is as simple as replacing worn washers in faucets.
- **Maximize Use of Most-Water-Efficient Equipment.** In most laundry operations, equipment is replaced through attrition, only when it stops working adequately. As a result, it is common for a facility to have more than one type of washer. In general, newer machines likely operate more water-efficiently than older ones. Water use can be determined by (a) checking the manufacturer's technical specifications, or (b) by disconnecting the washer discharge and capturing the wastewater in a temporary holding tank. Once the water use is determined, facilities should schedule larger jobs using the most water-efficient machine. Of course, once a washing machine reaches the end of its useful life, it should be replaced with the most water- and energy- efficient machine available (see Section 5.1.2).

6 San Francisco, Public Utilities Commission, Water Conservation Section.

5.1.2 Water-Efficient Laundering Equipment

In addition to procedural water conservation strategies, there are several process changes to reuse water and new equipment that operates more efficiently than what was available years ago. Implementing these BMPs will require a noticeable change in the existing process and will require an initial capital investment; however, they can result in water savings between 30 and 70 percent. Vendor information for each of the technologies discussed below is provided in Section 11.

- **Install Continuous Batch Washers.** Unlike conventional top- or side-loading washing machines, continuous batch washers—or tunnel batch systems—operate as a process line, where dirty garments are fed into one end and come out clean on the other (see Figure 5-3). Continuous batch washers with countercurrent flow captures water used in the final rinse process and re-circulates it earlier in the wash cycle, using up to 70 percent less water and steam than conventional washer extractors of similar capacity[7].
- **Retrofit Washer-Extractors to Reuse Final Rinse Water.** Existing washing machines may be retrofitted with washer-extractors that capture water used in the final rinse stage and reuse it in the pre-soak or initial washing phase (see Figure 5-3). New washing machines equipped with a self-contained extractor may be installed, or existing equipment may be retrofit with an adjacent water recovery

FIGURE 5-3 | CONTINUOUS BATCH WASHER AND WATER RECOVERY TANK

Continuous batch washers (left) and washer-extractors (right) may be installed in laundry operations to improve water efficiency. Photos courtesy of Girbau Laundry Equipment.

tank. Re-using the water from the rinse phase for the following pre-wash and wash phases allows the water consumption to be reduced by about 40 percent[8].

7 Sydney Water, Every Drop Counts, December 2001.

8 Girbau Commercial Laundry Division, www.laundryequipment.girbau.com

5.2 Boiler Operation

As discussed in Section 2.2.4, all garment factories generate steam using on-site boilers to supply ironing operations. Ironing is the last step before factory workers package the garments and ironing is performed continuously during factory operation. Most ironing platforms are equipped with exhaust systems to draw steam through the ironing surface and ventilate it to the outdoor environment. Garment factories typically have a boiler dedicated to the ironing process and use diesel-fired boilers and tank systems.

5.2.1 Recycling of Boiler Condensate

When steam is generated by a boiler and transferred through the system for ironing, it condenses—some of it changes from a gas back to a liquid—and is often redirected back to a holding tank commonly referred to as a condensate receiver. One of the easiest ways to minimize water use in a boiler operation is to increase the condensate return to the boiler. As more condensate is returned, less makeup water is required to meet the demand on the supply side for steam generation. Reusing condensate also increases the energy efficiency of a boiler operation (see Section 4).

To increase the condensate reuse rate, a boiler system must be equipped with a condensate receiver and condensate pump. The condensate receiver is a storage tank where return condensate is collected prior to reuse in a boiler; therefore, the receiver needs to be sized large enough to prevent condensate overflow and avoid unnecessary additions of fresh makeup water. There are several factors for selecting an appropriately-sized condensate pump[9]:

- System size
- Required discharge pressure
- Net positive suction head available (NPSHA) of the system
- Temperature of the condensate
- Amount of makeup water required due to leakage
- Steam consumed in industrial processes

Condensate Recycling: Ha Noi Company

(adapted from the e-Textile Toolbox)

Ha Noi Company, a state-owned garment and textile company in Viet Nam, produces mainly cotton knitted wear for domestic market and export. In 2002, the company initiated a cleaner production program and discovered their water consumption benchmark was about four times the industry average.

As part of a the cleaner production initiative, Ha Noi Company implemented a system to recycle boiler condensates in the dyeing section of the facility. Spending about $10,000 on galvanized pipes, holding containers, a water pump, and other materials, Ha Noi Company realized annual savings of $34,000 through a 179,712 ton (7 percent) reduction in fuel consumption and a 44,928 cubic meter (4 percent) reduction in water consumption. The payback on investment was about 3 months.

9 Condensate Considerations: A Pump Primer. Engineered Systems, August 2001.

- Change in load rate during various time periods

5.2.2 Preventive Maintenance for Leak Identification and Repair

Like a dripping faucet, leaks in the steam generation and distribution systems can waste thousands of gallons of water and the heat energy it contains. Developing an inspection schedule to routinely check all water and steam lines, pumps, and valves for leaks can minimize such losses. Leaks in boiler systems may occur in faulty steam traps and flange gaskets, worn valve seats and packing, long pipe runs, missing or deteriorated insulation, or leaking makeup- or condensate-return systems[10]. Leaks should be repaired promptly after being identified. Figure 5-10 (included at the end of this section) provides an example leak identification checklist for use in your facility.

5.3 Dormitory Bathrooms

Residential bathroom water use—including toilets, showering, and faucets— typically accounts for 2/3 of all indoor residential water use.[11]

For garment factories, the cost and environmental impact of domestic water use is directly proportional to the number of employees living in on-site dormitories. However, even in facilities that do not have on-site employee housing, several of the following BMPs may be applied to restrooms located in the production and administrative areas.

As illustrated in Figure 5-4, water use from toilets and faucets can total about 40 gallons per day per person in the absence of conservation measures. If employees are showering on site, that total increases to over 90 gallons per day per person. The following low-cost BMPs can be implemented immediately and, when actively maintained through simple employee awareness efforts, will reduce the daily water use in bathroom facilities by over 50 percent.

10 Water Efficiency Measures for Boilers and Steam Generators, City of Calgary.

11 How to Conserve Water and Use it Effectively. U.S. Environmental Protection Agency, Office of Water.

5.3.1 Water-Efficient Showerheads

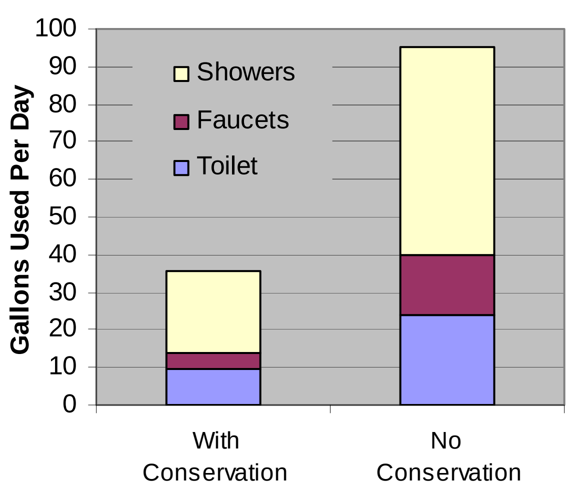
Showers represent the largest consumer of water in dormitories. The showers observed during the P2 assessments were mostly without showerheads or equipped with simple nozzles with no flow restrictions and used about 3-5 gallons per minute (gpm). A much smaller portion of the showerheads were water-efficient showerheads. The Energy Policy Act sets the maximum flow for showerheads at 2.5 gpm at 80 pounds per square inch (psi) or 2.2 gpm at 60 psi; however, water-efficient models that do not compromise shower pressure are available between 1.5 and 2.2 gpm. Because shower water is also heated, installing low-flow showerheads or aerators not only saves water, but energy as well. Figure 5-5 compares the lifetime water costs for standard and low-flow showerheads. There are two types of low-flow showerheads[12]:

Do a Flow Test!

Not sure of how much water a showerhead uses? Place a 5-gallon bucket under the showerhead and turn on the shower. If the bucket is half-full after one minute, the showerhead should be replaced with a low-flow replacement.

- **Aerating** showerheads mix air into the water stream. This maintains steady pressure so the flow has an even, full shower spray. Because air is mixed in with the water, the water temperature can cool down a bit toward the floor of the shower. Aerating showerheads are the most popular type of low-flow shower head.
- **Non-aerating** showerheads do not mix air into the water stream. This maintains temperature well and delivers a strong spray. The water flow pulses with non-aerating showerheads, giving more of a massaging-showerhead effect.

FIGURE 5-4 | DAILY BATHROOM WATER USE



The actual performance of showerheads—even among models with the same flow rate—can vary substantially due to variations in water pressure and spray patterns. The actual flow rate and performance will depend on local water pressure. In areas with hard water, mineral buildup can clog showerheads resulting in significantly less flow than what they are rated.

12 Low-Flow Aerators, www.Eartheasy.com

FIGURE 5-5 | COMPARATIVE LIFETIME WATER COSTS FOR SHOWERHEADSFIGURE

Adapted from "How to Buy a Water-Saving Showerhead," U.S. Department of Energy, Federal Energy Management Program.

	Base Model 5.0 gpm	Efficient Model 2.5 gpm	Best Available 1.5 gpm
Showerhead Cost (Based on vendor-provided information; actual cost may vary.)	$5	$6	$12
Showering Cost			
Annual Water Use Estimated annual water use assuming 10 minutes per shower, 365 days per year.	18,250 gallons	9,125 gallons	5,475 gallons
Annual Water Cost Estimated annual water cost assuming combined water and wastewater costs of $3.94 per 1,000 gallons.	$71.90	$35.95	$21.57
Lifetime Water Cost Discounted value of annual water cost, assuming showerhead life is 10 years.	$719	$360	$216
Energy - Water Heating	**per capita**	**per capita**	**per capita**
Annual Energy Use Water temperature assumed to be 106°F with an inlet water temperature of 58°F and pressure of 80 psi.	2,354 kw-hr	1,177 kw-hr	706 kw-hr
Annual Energy Cost (water heated electrically) CUC electricity price is $0.20/kWh.	$470	$235	$141
Lifetime Energy Cost Sum of the discounted value of annual energy cost, assuming showerhead life is 10 years.	$4,700	$2,350	$1,410
10-Year Cost (per capita)	$5,419	$2,710	$1,626
10-Year Savings (per capita)	**--**	**$2,709** **9,125 gallons** **1,177 kw-hr**	**$3,793** **12,775 gallons** **1,648 kw-hr**

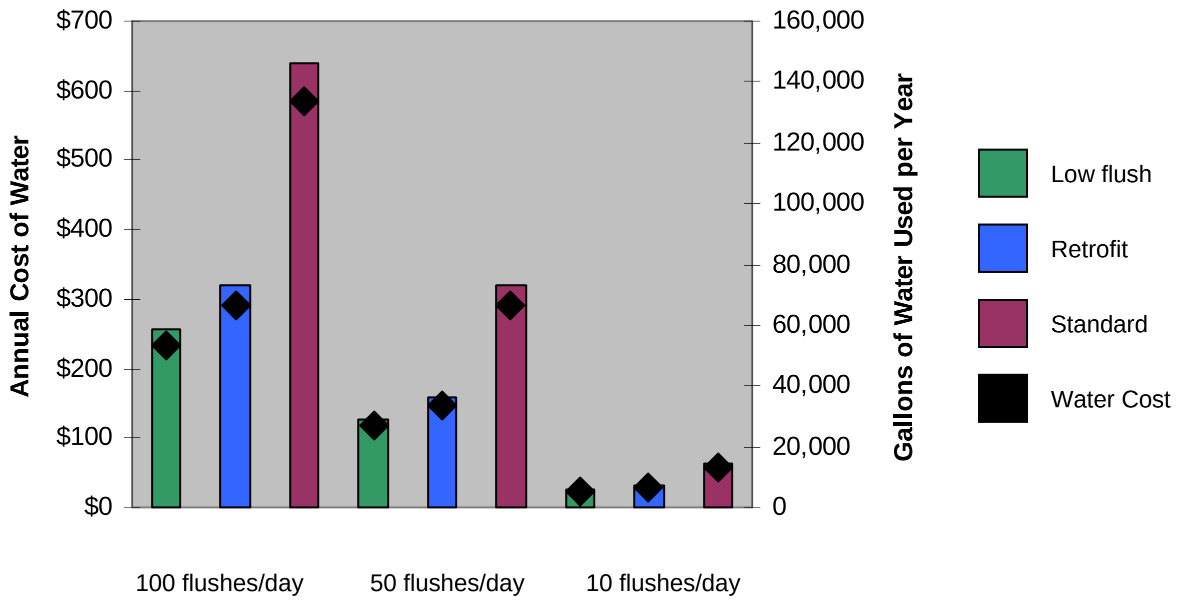
www1.eere.energy.gov/femp/procurement/eep_showerhead.html.

5.3.2 Water Efficient Toilets

Toilets—both in dormitories and factory areas—offer an easy opportunity to significantly reduce the amount of water used in bathrooms. At 3.5 gallons per flush, toilets use nearly 40 percent of all indoor residential water use[13]. Most of the toilets observed during the P2 assessments were older, water-intensive models. This section provides information on low-cost techniques for minimizing the water use associated with existing models, as well as guidance on purchasing new, low-flow toilets. Figure 5-6 compares the average water use and cost for standard, displacement retrofit, and low-flush toilets.

FIGURE 5-6 | COMPARATIVE WATER USE FOR TOILETS

	Standard	Retrofit	Low Flush
Purchase Cost	Existing	$50 (parts and labor)	$250
Water Use Per Flush	4-5 gallons	2 gallons	1.6 gallons



13 How to Conserve Water and Use it Effectively. U.S. Environmental Protection Agency, Office of Water.

Implement Preventive Maintenance for Leak Identification and Repair

A "running" toilet can waste 2 gallons of water per minute, or up to 7,000 gallons per month.[14] Fortunately, identifying a leaky toilet simply requires listening, looking, and simple monitoring. Figure 5-10 (included at the end of this section) provides an example leak identification checklist to help implement a proactive preventive maintenance schedule in your facility. Many leaks can easily be identified by listening for running water or looking for water movement in the toilet bowl when the toilet should be idle. However, sometimes toilets leak very slowly with no sound or visual evidence. To identify such leaks, put a few drops of food coloring into the tank and do not flush the toilet for ten minutes.[15] If the coloring begins to appear in the toilet bowl without flushing, you have identified a silent leak that should be repaired.

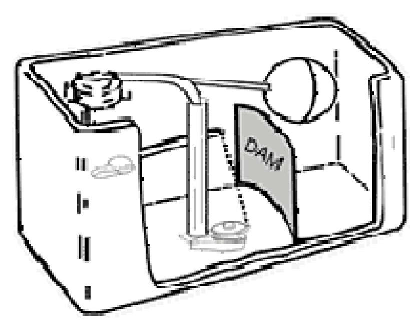
Toilet leaks are typically caused by either a worn out flapper valve or a fill valve that does not shut off completely when the tank is full. Flappers deteriorate over time with exposure to water and eventually begin a slow but constant leak. Similarly, fill valves weaken with age and fail to shut off after the tank is full, resulting in water slowly pouring over the top of the tank's overflow tube. These devices should be replaced periodically as part of the routine plumbing maintenance. Fortunately, they are relatively inexpensive and easy to fix.

Retrofit Older Toilets

If you are unable to immediately purchase new, low-flush toilets, consider installing simple water displacement devices or make other modifications to older toilets to minimize the amount of water used for each flush. These devices can typically save between 1 and 2 gallons of water per flush. Cost, reliability, and ease of installation should be evaluated when determining which toilet retrofit project is most appropriate. Furthermore, all toilet retrofit projects require monitoring to ensure they are properly installed and functioning adequately. Following are two types of retrofit projects to reduce water flow in older toilets:

- **Flush Valve Modifications.** An old toilet's flush valve can be replaced with an early closure flush valve to reduce the amount of water used for each flush. An early closure device forces the flush valve to close early, prohibiting the full volume of the tank to be discharged each flush. However, since the tank is full of water, the force of the flush is powered by about the same pressure as it was prior to installation of the early closure flush valve. The force

FIGURE 5-7 | WATER DISPLACEMENT DAM



14 Water Conservation Tips. San Francisco Public Utilities Commission, Water Conservation Section.

15 Ensure that the food coloring will not stain the toilet.

of the flush may be enhanced by raising the water column in the tank to the highest level possible.

- **Water Displacement Devices.** Devices such as displacement bags, containers, or toilet dams save water each time the toilet is flushed by taking up space in the tank and preventing it from fully filling with water. A water displacement device may be as simple as a gallon jug filled with rocks that fits in the tank or a toilet dam that prevents a section of the tank from filling between flushes. These devices should be installed carefully so as to not interfere with the flushing mechanism or flow of water.

FIGURE 5-8 | SUMMARY OF TOILET RETROFIT PROJECTS

Description	Cost	Considerations
Early closure flush valve forces the flush valve to close before the full volume of the tank is flushed.		Moderately difficult installation.
Dual flush device allows the user to choose two levels of flushing, often 1.6 and 0.8 gallons.		Moderately difficult installation. Requires user behavior change.
Displacement bags/containers take up space in the tank and prevent it from fully filling with water.		Easy installation; may move and interfere with flushing mechanism.
Toilet dam prevents a section of the tank from filling between flushes.		

Purchase Low-Flush Toilets

In the United States, the Energy Policy Act of 1992 requires that all new toilets produced for home use after January 1, 1994 must operate on 1.6 gallons per flush or less. These low-flush toilets use less than half the amount of water of standard toilets; therefore, garment factories that choose to replace older toilets with these water-efficient models can save tens of thousands of gallons of water per year (See figure 5-6). Also, because toilets in garment factories and dormitories are used—and therefore flushed—frequently, the potential for water savings is much higher than in a typical residential setting. Therefore, replacement of conventional toilets with low-flush toilets is economically justifiable. New low-flush toilets cost between $250 and $450 but the payback period can be as little as 18 months for a toilet that is flushed 50 times daily.

FIGURE 5-9 | LOW-FLUSH TOILET INVESTMENT ANALYSIS

	Standard	Low Flush
Investment	--	$250
Water Use Per Flush	4-5 gallons	1.6 gallons
100 Flushes Daily		
Monthly Water Use:	12,000 gallons	4,800 gallons
Monthly Water Cost:	$50	$20
Payback Period:	0.7 years	
50 Flushes Daily		
Monthly Water Use:	6,000 gallons	2,400 gallons
Monthly Water Cost:	$25	$10
Payback Period:	1.4 years	

When replacing a conventional toilet with a low-flush model, “snake” the drain lines prior to installing the new fixture. Doing so is good preventive maintenance and will ensure that the drain is completely unobstructed for installation and use of the new toilet fixture. For initial installation of a low-flush toilet, "snake" drain lines and replace the entire fixture. After the new low-flush toilet is in place, only standard maintenance required for any type of toilet—such as monitoring the function of the valves and ballcock—is required.

FIGURE 5-10 | LEAK IDENTIFICATION CHECKLIST

Quarterly Inspections

- **Water Meter Validation.** After operating hours, turn off all water-using equipment and record the water meter reading. Record the meter reading again after 2 hours when no water-using equipment has been used. Any difference in the readings indicates a leak somewhere in the facility.

Inspected By	Date	Initial Reading	+ 2-Hour Reading
	Quarter 1 (January)		
	Quarter 2 (April)		
	Quarter 3 (July)		
	Quarter 4 (October)		

Monthly Inspections

- **Visual Inspection.** Visually inspect all exterior laundry and boiler plumbing, restroom and kitchen faucets, toilets, outdoor spigots, and other observable water sources for drips or leaks. Also note any observed water on the floor of the facility. Determine the location and cause of any leak you find and repair it.

Inspected By	Date	Leaks Observed	Repair Date
	January		
	February		
	March		
	April		
	May		
	June		
	July		
	August		
	September		
	October		
	November		
	December		

6.0 FOCUS AREA 3: SOLID WASTE GENERATION

Over the past 10 years, Saipan has dramatically changed the way it manages solid waste. Prior to the opening of the Marpi Landfill and Lower Base Transfer Station in October 2000, the now-closed Puerto Rico Dump received all solid waste generated on the island. With the opening of the new facilities, the CNMI DPW implemented a per ton fee for all solid waste disposal. While fee-based solid waste disposal is standard practice on the U.S. mainland, the practice is relatively new to Saipan businesses, which were able to dispose of solid waste at the Puerto Rico Dump for free. The new Marpi Landfill currently operates under a simple rate structure: $25 per ton for municipal solid waste and $35 per ton for special wastes, which include items such as appliances, scrap tires, and other wastes requiring special handling and additional environmental controls. Special wastes also include fabric waste from garment factories (contact DPW to obtain the latest information on special waste and to obtain a Disposal Information Sheet). Despite the fee-based rate structure, revenues do not cover DPW's operational costs for the Marpi Landfill. As a result, CNMI is considering increasing tipping fees for 2006.

The garment manufacturing industry is the single largest source of solid waste on Saipan, generating about one-third of all solid waste on the island.

A waste characterization study conducted in 1999 by CNMI DPW identified the garment factories as the single largest source of solid waste on Saipan, generating about one-third of all solid waste on the island (Saipan Integrated Solid Waste Management Plan, November 2005). Because most of the waste generated by these facilities is scrap fabric—a special waste that costs more to dispose of than standard municipal solid waste—the Saipan garment factories have a special interest in minimizing disposal costs by diverting fabric waste through recycling. While the fabric waste is by far the largest component of solid waste from garment factories, other opportunities to minimize solid waste disposal through source reduction and recycling do exist. Garment factories should conduct a visual solid waste characterization to help identify what solid waste they generate and what materials can potentially be diverted and recycled (see Figure 6-5, included at the end of this section). To extend the life of the new Marpi

FIGURE 6-1 | GARMENT MANUFACTURING SOLID WASTE GENERATION

Solid Waste - Manufacturing Processes	
Receiving	Cardboard boxes from receiving accessories and sewing supplies; plastic wrap from receiving bulk fabrics.
Spreading, Form Layout, and Cutting	Scrap fabrics from cutting garments.
Solid Waste – Supporting Operations	
Employee Housing	Residential solid waste.
Food Preparation	Food scraps from food preparation; minimal post-consumer food-waste or food packaging waste.

Landfill, CNMI has established recycling services on Saipan and as a result there are readily available opportunities for garment factories to minimize solid waste disposal.

Figure 6-2 provides an overview of the BMPs discussed in this section. For each BMP, a quantitative score is provided based on a scale of 1 (low) to 5 (high) for capital requirements and potential solid waste reduction impact. The priority score is calculated as follows:

Priority Score = (waste reduction score) – (capital requirements score)

The resulting priority score can be interpreted as follows for the recommended BMPs:

- **Positive Priority Score.** Indicates that the recommended BMP will reduce solid waste generation and provides a short payback period on capital investments. *The higher the priority score, the greater the return on investment.*
- **Zero Priority Score.** Indicates the BMP has balanced costs and benefits; both scores could be high or low. *These BMPs should be additionally considered for capital available when compared to other potential BMPs.*
- **Negative Priority Score.** Indicates the recommended BMP will reduce solid waste generation, but the payback period on capital investments is longer than BMPs will higher priority scores. *The lower the prioritization ranking, the longer it will take to recoup capital investments.*

FIGURE 6-2 | SOLID WASTE BEST MANAGEMENT PRACTICES

Best Management Practice	Waste Reduction	Capital Requirements	Priority Score*
Recycle scrap garments using a solid waste contractor.	5	2	3
Recycle scrap garments using in-house staff and transportation.	5	3	2
Divert other recyclable materials.	3	1	2
Divert food scraps to local animal farms.	2	1	1

1	2	3	4	5
Low		Moderate		High

* Priority Score = (Energy Saving Score) – (Capital Requirements Score)

6.1 Garment Scrap Recycling

Scrap fabric is almost entirely generated in garment factory cutting rooms. Very small amounts are rarely generated from the sewing line and quality control areas when whole garments are rejected for quality purposes and cannot be sold as seconds. The 1999 Saipan Waste Characterization Study estimates that about 25 percent of all solid waste generated on Saipan is scrap garments (Saipan Integrated Solid Waste Management Plan, November 2005). Of this, the study estimates that 5 percent is made of cotton or other natural fibers and can be recycled at the Materials Recovery Facility (MRF), a recycling center located near DPW's Lower Base refuse transfer station. The Green Garments Project facility assessments revealed an increased use in natural fibers; therefore, it is likely that a greater percentage of scrap garment material may be recycled in the future. The following sections provides an overview of the DPW garments recycling program and recommendations for ensuring that solid waste contracts are structured to provide an economic incentive for segregating scrap garments from other solid waste.

6.1.1 Department of Public Works Garment Recycling Program

Scrap fabric requires special handling for disposal; therefore, it is considered a special waste and costs $35 per ton for disposal at the Marpi Landfill. Waste hauling vehicles are visually inspected upon arrival at the Lower Base Refuse Transfer Station, and if scrap fabric is identified, the higher disposal fee is applied to the load. To provide an economic incentive for garment manufacturers to segregate and divert their scrap garments from Saipan's solid waste stream, CNMI DPW established the following garment recycling program:

- Segregated garments, mixed with minimal amounts of plastics or other materials, may be dropped off at the Lower Base garment recycling facility at no cost.
- The facility is managed by a contractor who is responsible for properly segregating, baling, and coordinating sale of the material to an off-island recycler.
- CNMI DPW requires the contractor to recycle at least 80 percent of the materials received at the facility; the remaining materials are disposed of at the Marpi Landfill.

DPW requires recycling of at least 80 percent of the segregated scrap garment material accepted by the Lower Base garment recycling facility.

Many of the garment factories in Saipan were unsure whether their scrap garment materials were being recycled; however, Saipan solid waste service contractors are indeed diverting scrap fabric to the garment recycling program because of the considerable cost savings associated with recycling over disposal.

6.1.2 Understanding Your Solid Waste Service Contract

Because garment factories in Saipan often subcontract solid waste disposal services, most facility managers were largely unaware of the solid waste disposal protocols. Furthermore, most garment factories' solid waste service contracts are fixed-fee, meaning that the waste hauler charges a fixed rate per month, regardless of the amount of solid waste collected. Fixed fee contracts are easily managed, but do not (1) provide an economic incentive for solid waste diversion, or (2) allow for accurate, quantitative tracking of the amount of solid waste generated. Garment manufacturers should work with their solid waste contractors to implement the following:

Scrap garments can be disposed of as a special waste for $35 per ton or dropped-off at the CNMI DPW garment recycling facility free.

- **Dedicated container for segregated scrap fabric** (see Figure 6-3)**.** Garment facilities should have a clearly labeled container used solely for the collection of scrap fabric. Smaller collection bins located at points of generation—such as the cutting floor and sewing line—should also be clearly labeled to prevent other materials from being discarded in the "scrap fabric" containers.
- **Solid waste disposal reporting.** As discussed in Section 3, environmental performance indicators such as solid waste generation are becoming increasingly important measures of business performance. Your solid waste hauler should provide quantitative information on how much material is both landfilled and recycled.

FIGURE 6-3 | SEGREGATING SCRAP GARMENT MATERIALS FOR RECYCLING

Garment factories should have separate dumpsters for scrap garments (left) and solid waste (right).

Because scrap fabric can be recycled at no cost using the CNMI DPW garment recycling program, garment factories using solid waste contractors are paying for the service of providing pickup, handling, and transportation of scrap fabric to the CNMI DPW recycling facility. Each garment factory may consider this service a good value and may wish to continue using the solid waste contractors, but in any case, garment factories would be wise to evaluate their existing contracts and understand what their payment covers.

Since a large percentage of a garment factory's waste stream, often up to 75 percent or more, is scrap fabric, properly segregating scrap garment materials may provide negotiating leverage for lowering the cost of the solid waste contractor's service. Alternatively, garment factories may find it cost effective to use in-house equipment and staff to transport the segregated scrap fabric to the CNMI DPW garment recycling facility, located in the lower base road near the Saipan port. Figure 6-6 (included at the end of this section) provides a worksheet for conducting a cost analysis of solid waste disposal options.

6.2 Diverting Other Recyclable Materials

Other recyclable materials such as cardboard, paper, and aluminum, while not as large a component of the solid waste stream as scrap fabrics, can also be diverted from a garment factory's waste stream to reduce solid waste disposal. There are two basic factors that determine what materials should be recycled:

- **Quantity of Recyclable Materials Generated On-Site.** Garment factory staff should conduct a visual characterization of solid waste in the collection points in each process area to identify what materials can easily be segregated and recycled (see Figure 6-5, included at the end of this section).
- **Availability of Local Recycling Markets.** Due to the high cost of shipping recyclable commodities off-island, the local recycling market is determined by what materials are accepted by the CNMI DPW recycling center, which serves as a centralized collection point for the island and enables efficient processing and sale of recyclable materials. The recycling center accepts a variety of materials, including:
  - Aerosol cans
  - Aluminum
  - Cardboard
  - Glass
  - Mixed paper
  - Newspaper
  - Office paper
  - Plastics
  - Scrap metal

  CNMI DPW can provide details of the materials it accepts at the recycling center.

Except for scrap fabric, the solid waste generated by garment factories is typical of other commercial operations. Figure 6-4 summarizes considerations for diverting some of the most commonly generated recyclable materials. Like scrap fabrics, recyclables taken to the CNMI DPW recycling center can be dropped off at no cost. As a result, by implementing a significant recycling program, a garment manufacturer could potentially negotiate lower-cost waste disposal services; alternatively, it may be cost efficient to transport recyclables to the CNMI DPW garment recycling facility using in-house resources. Figure 6-6 (included at the end of this section) provides a worksheet for conducting a cost analysis of solid waste disposal options.

FIGURE 6-4 | CONSIDERATIONS FOR DIVERTING OTHER RECYCLABLE MATERIALS

Aluminum and Plastic Beverage Containers

- Generated in administrative offices and on-site dormitories.
- Limited quantities are generated; however, collecting these items increases visibility of the recycling program and employees' sense of participation in it.
- CNMI DPW Recycling center pays $0.25 per pound for aluminum cans.

Cardboard

- Often generated in just one or two areas of the facility; therefore, can easily be segregated for recycling.
- Must be stored in a dry area to prevent material from becoming soiled and un-recyclable.

Paper

- Generated in administrative offices. Collecting paper may also increase employees' sense of participation in the recycling program.
- Facilities using paper patterns on the cutting floor should consider collecting and recycling this material.

6.3 Diverting Food Scrap Waste

Garment factories with on-site kitchens should consider segregating food preparation waste, particularly organic waste like vegetable scraps, and diverting it as feed to a local animal farm. While food waste represents a relatively small percentage of the factory's solid waste stream, implementing a food waste diversion program is a no-cost opportunity to reduce what is sent to the landfill. Several garment factories that participated in the Green Garments on-site assessments had such programs in place: food scraps were stored in a sealable plastic container and picked up by their solid waste contractor. Such programs demonstrate business-to-business stewardship that benefits the Saipan community, particularly since animal feed is expensive on the island.

<u>REUSE BEFORE RECYCLING</u>. When possible, materials should be reused before they are recycled or discarded, for example:

1. Reuse bobbin spools internally or return them to the manufacturer for reuse.

2. Reuse pallets or identify a local business that can use them in their operation.

FIGURE 6-5 | SOLID WASTE CHARACTERIZATION WORKSHEET

Solid Waste Characterization Procedures

- **Visual Inspection and Volume Estimate.** At a minimum, complete a visual inspection of each dumpster at your facility and estimate the percentage by volume of each waste stream component. For a more comprehensive waste characterization, conduct a visual inspection of each collection area (cutting floor, receiving area, etc.).
- **Generation Process.** For each recyclable commodity, indicate all processes that generate the material. For example, cardboard may be generated by receiving and box making, and identifying its source will help identify areas of the facility where the commodity could be source separated.

Inspected by: **Date:**

Dumpster/Collection Area:

Commodity	Percent by Volume	Generation Process
Aerosol cans		
Aluminum beverage containers		
Plastic beverage containers		
Cardboard		
Fabric scrap (natural)		
Fabric scrap (synthetic)		
Glass		
Mixed paper*		
Scrap metals		
Other: _____________		
Other: _____________		

* *Mixed paper may include (but is not limited to) office paper, newspaper, magazines and catalogs, letterhead, and colored paper. For a more information, contact CNMI DPW.*

FIGURE 6-6 | SOLID WASTE DISPOSAL COST ANALYSIS WORKSHEET

Part A | Solid Waste Service Contract Review

Contractor name:		**Contract period:**	
Fixed fee contract?	☐ No ☐ Yes	**Monthly fee:**	A1
List the commodities your waste hauler recycles from your facility:			

Part B | Estimating Monthly Solid Waste Disposal

Estimate the total volume of solid waste removed (disposed of or recycled) **each month**.

Dumpster Size	Quantity	Frequency	Volume Calculation	Cubic Yards Per Month
4 cubic yards			4 x quantity x frequency =	
6 cubic yards			6 x quantity x frequency =	
8 cubic yards			8 x quantity x frequency =	
10 cubic yards			10 x quantity x frequency =	
			Total Cubic Yards per Month:	B1

Part C | Volume to Weight Conversion

Estimate the weight of solid waste removed (disposed of or recycled) **each month**.

Waste Type	A Total Cubic Yards Per Month	B Weight per Cubic Yard (tons)	C Percentage of Waste (by volume)	Volume to Weight Calculation	Weight (tons)
EXAMPLE	*2500*	*0.05*	*.02*	*A x B x C*	*2.5 tons*
Aluminum Cans	Use calculation from cell B1 in Part B above.	0.03	.02	A x B x C	C1
Cardboard		0.05	.25	A x B x C	C2
Garments (natural)		0.11	.15	A x B x C	C3
Garments (synthetic)**		0.11	.10	A x B x C	C4
Glass		0.3	.02	A x B x C	C5
Mixed paper		0.3	.08	A x B x C	C6

FIGURE 6-6 | SOLID WASTE DISPOSAL COST ANALYSIS WORKSHEET						
Office Paper		0.3	.03	A x B x C		C7
Scrap metals		estimate	.05	A x B x C		C8
Miscellaneous**		estimate	.30	A x B x C		C9
				Tons per Month:		C10

Notes: *Volume to weight conversion factors from Business Guide for Reducing Solid Waste, EPA, November 1993 except for fabric conversion which is from the California Integrated Waste Management Board, www.ciwmb.ca.gov/agendas/mtgdocs/2000/10/00004792.doc*

Percentage of waste stream estimates based on 1999 Waste Characterization Study and observations during Green Garments site assessments. These numbers may be adjusted to reflect facility-specific conditions using the Solid Waste Characterization Worksheet provided in Figure 6-6.

*** Non-recyclable wastes; all other items listed are accepted by the CNMI DPW recycling center.*

Part D | Solid Waste Disposal Cost Analysis

Using the information calculated above, complete the following to determine (1) the estimated cost per ton for disposal under the existing solid waste service contract; (2) estimated disposal costs at the CNMI DPW Lower Base Transfer Station; and (3) estimated transportation and service fee incurred under solid waste service contract.

<u>Fixed Fee Solid Waste Contract Analysis</u>			
Monthly solid waste contract fee: (A1)		______________	
Total tons per month: (C10)		______________	
Estimated monthly cost per ton: (C10 ÷ A1)		______________	D1
<u>Saipan Landfill Disposal Cost Analysis</u>			
Total Recyclable Materials: (C1 + C2 + C3 + C5 + C6 + C7 + C8)	*The CNMI DPW recycling center accepts these materials at no cost.*	______________	tons
Non-Recyclable Waste: (C9 x $25)	*Disposal cost: $25 per ton at the Marpi Landfill.*	______________	D2
Special Waste: (C4 x $35)	*Disposal cost: $35 per ton at the Marpi Landfill.*	______________	D3
<u>Estimated Transportation and Service Fee</u>			
Estimated Transportation Cost/Fee: (A1 – D2 – D3)	*Based on monthly fixed fee and disposal fees at Marpi Landfill.*	______________	D4

7.0 HAZARDOUS CHEMICAL USE

Unlike fabrication and dyeing processes associated with textile manufacturing, a comparatively small component of garment manufacturing operations require hazardous chemical use. As illustrated in Figure 3-3 (see Section 3), the Green Garments Project evaluated the following three processes using hazardous chemicals: screen printing, spot cleaning, and sewing (machine maintenance). The assessment found that only a small percentage of garment factories had in-house screen printing operations, and while all garment factories perform routine sewing machine maintenance, very few chemical products are used. However, all garment factories had on-site spot removal operations, some with several work stations staffed each day. Garment factories use various techniques for spot removal, but most often a chlorinated solvent is applied to remove the spot.

FIGURE 7-1 | SOLVENT USE FOR SPOT CLEANING

Chlorinated solvents are commonly used to spot clean garments.

As a result, this section focuses on minimizing the use of chlorinated solvents for spot-cleaning garments because of their wide use and significant environmental concerns. Figure 7-2 provides an overview of the BMPs discussed in this section. For each BMP, a quantitative ranking is provided based on a scale of 1 (low) to 5 (high) for capital requirements and potential chemical-use impact. The priority score is calculated as follows:

Priority Score = (chemical reduction score) – (capital requirements score)

The resulting priority score can be interpreted as follows for the recommended BMPs:

- **Positive Priority Score.** Indicates that the recommended BMP will reduce hazardous chemical use and provides a short payback period on capital investments. *The higher the priority score, the greater the return on investment.*
- **Zero Priority Score.** Indicates the BMP has balanced costs and benefits; both scores could be high or low. *These BMPs should be additionally considered for capital available when compared to other potential BMPs.*
- **Negative Priority Score.** Indicates the recommended BMP will reduce hazardous chemical use, but the payback period on capital investments is longer than BMPs will higher priority scores. *The lower the prioritization ranking, the longer it will take to recoup capital investments.*

FIGURE 7-2 | HAZARDOUS CHEMICAL USE BEST MANAGEMENT PRACTICES

Best Management Practice	Chemical Reduction	Capital Requirements	Priority Score*
Identify and correct the cause of garment spotting.	3	1	2
Minimize chlorinated solvent use through efficient application.	2	1	1
Use alternative spot-removal techniques.	3	2	1
Use alternative spot-removal agents.	4	2	2

1	2	3	4	5
Low		Moderate		High

* Priority Score = (Energy Saving Score) – (Capital Requirements Score)

Like approximately 80 percent of the dry cleaners located in the mainland United States, Saipan's garment factories use primarily chlorinated solvents for spot cleaning[16]. Perchloroethylene (PCE), methylene chloride, n-hexane, and trichloroethylene (TCE) were the most commonly used spot cleaning solvents observed during the Green Garments site assessments. Because many chlorinated solvents are suspected carcinogens[17] and common groundwater contaminants, their use is increasingly regulated and requires strict environmental, health, and safety controls. If exposure is not properly controlled, these chemicals may pose serious health hazards to garment factory staff, specifically those who routinely breathe the solvent vapor or spill the chemical on their skin.

While garment factories may not be able to fully eliminate use of these chemicals, the following sections discuss several ways to minimize the amount required to perform spot cleaning tasks, including:

- **Minimizing spotting occurrences**, thus reducing the number of garments requiring spot removal.
- **Ensuring efficient application** of the solvent by using proper dispensing tools.
- **Using alternative spot-removal techniques** that do not require the use of PCE or other chlorinated solvents.

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16 "Dry Cleaning Dreams," *Chemical and Engineering News*, Volume 83, Number 46. November 14, 2005.

17 PCE is designated a "potential occupational carcinogen" by the National Institute for Occupational Safety and Health (NIOSH), "reasonably anticipated to be a human carcinogen" by the National Toxicology Program, and a "probable human carcinogen" by the International Agency for Research on Cancer (IARC).

- **Using environmentally preferable spot-removal agents** that present less risk to worker health and the environment.

7.1 Minimize Spotting Occurrences

The best way to minimize the use of spot cleaners is to reduce the occurrence of spots in the first place through aggressive detection and corrective procedures on the sewing lines. During the Green Garments site assessments, several Saipan garment factories indicated that most spotting occurs as a garment is sewn and attributed most spotting to sewing machine lubrication oil. Therefore, the policies and procedural changes described below focus on this area of the factory.

- **Purchase sewing machines that do not require lubricants to minimize garment staining.** When purchasing new equipment, garment factories should look for machines that require no or very little lubrication to minimize spotting occurrences. For example, Brother Industries offers an electronic direct-drive lockstitch bar tacker that does not require lubrication. Alternatively, garment factories could explore using non-petroleum based lubricants, which may result in either (1) fewer spotting occurrences or (2) less-stubborn garment spotting that can be removed using alternative spot-removal agents (see Section 7.1.3). Either outcome would ultimately reduce the amount of solvent required for spot cleaning. However, garment factories should first ensure that the use of non-petroleum-based lubricants does not negate the sewing machine's manufacturer's warranty and initially test one machine to ensure that performance is not impacted.

FIGURE 7-3 | CHLORINATED SOLVENT STORAGE

Garment manufacturers must ensure proper storage and handling of chlorinated solvents used for spot removal.

- **Require routine cleaning of sewing surfaces to prevent spotting.** Simple housekeeping may be one of the easiest ways to prevent spotting from occurring on the sewing line. Requiring employees at each sewing station to wipe down the machine and work surface at the beginning, middle, and end of each shift could minimize the number of garments requiring spot cleaning.
- **Identify the cause of spotting during quality control inspections.** This procedure would most appropriately be integrated into the existing quality control inspection performed after garments come off the sewing line. As outlined in the sample procedure provided in Figure 7-4, just

a few basic questions can help determine the source of the spot and enable employees to prevent it from reoccuring.

FIGURE 7-4 | QUALITY CONTROL SPOT REMOVAL PREVENTION PROCEDURE

Date:

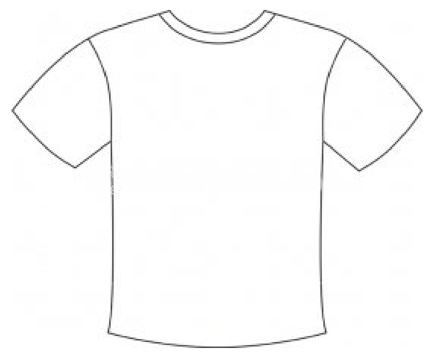
Inspected by:

Sewing line:

Spotting source:
- ☐ Sewing machine oil
- ☐ Fabric imperfection
- ☐ Dirt
- ☐ Other: ________________________

Action taken:

Indicate location(s) of spots below.



After five spots occur in the same location, pursue preventive action.

7.2 Minimize Solvent Use through Efficient Application

Saipan garment factories apply spot removers using both aerosol cans and compressed spray systems supplied by bulk solvent containers (see Figure 7-5). The quantity of solvent used can be minimized by selecting an application technique that (1) can be applied accurately by the user in a controlled manner and (2) dispenses the spot remover in a pattern appropriate for the size of the spot.

FIGURE 7-5 | SPOT CLEANING

Spot removers are applied using both aerosol and compressed spray systems.

During the Green Garments site assessments, garment factories indicated that most spots were very small—ranging from a mere speck to just a few milimeters. Of the two methods observed, the compressed spray systems better allow employees to apply the spot remover to very small areas. This application technique can be further improved by using a nozzle that restricts the output of the chemical. Aerosol cans have a fixed spray nozzle that allows little, if any, modification or adjustment. As a result, spray patterns and volumes from aerosol cans are mismatched to the spot most of the time by providing too much solvent or too large a spray pattern, resulting in overspray and inefficient use of the solvents. A common compensating technique used by workers performing the spot cleaning is to move the spray nozzle closer to the garment to reduce the size of the spray pattern. While this minimizes overspray, it does not reduce the amount of solvent (usually too much) being applied to a smaller area. Lastly, because aerosol cans contain propellents that act as carriers of the active ingredient, the can must be discarded when the propellent is exhausted, but typically 10 to 15 percent of the product remains in the can and is wasted.

7.3 Use Alternative Spot Removal Techniques

When possible, garment factories should use other, non-chemical-based cleaning techniques to remove spots. Depending on the characteristics of the spot, spots may be removed using water, compressed air, or another method to minimize the use of chemical spot removers. The following non-chemical-based spot-cleaning techniques were observed during the Green Garments site assessments:

- **Manual tweezing.** Often as part of the quality control inspection, lint and other visible particles were manually removed from the garment using tweezers (see Figure 7-6).
- **Compressed air.** Similar to manual tweezing, compressed air guns are often used to blow dust, lint, or other visible particulates off of garments. This technique is less time consuming than tweezing and can also be used to dry fabrics after spot treatments are applied.
- **Pressurized steam gun.** Steam guns provide heat, moisture, and force to flush dirt from fabrics. Special consideration should be given to this technique, as steam application may cause fabric color loss. Also, treated areas will need to be dried using compressed air; however, drying should occur slowly to minimize the chance of ringing. Use of pressurized steam may enhance the performance of non-solvent-based spot treatments.

FIGURE 7-6 | ALTERNATIVE SPOT REMOVAL TECHNIQUES

An employee spot cleans a garment using tweezers to remove lint.

7.4 Use Alternative Spot-Removing Agents

The issue of minimizing chlorinated solvent use is not limited to spot cleaning operations, but is a challenge to dry cleaners throughout the United States and around the world. For decades chlorinated solvents have been the dry cleaning and spot-removal chemical of choice, but widespread environmental concerns resulting from its use have prompted U.S.

EPA to evaluate alternative dry cleaning methods. Familiarity with alternative dry cleaning methods, even though they may not be directly applicable in a spot-cleaning context, may provide insight as to what other spot-cleaning chemicals may be available in the future. Alternatively, garment factories may wish to explore the feasibility of implementing a complete process change in spot cleaning by adopting one of the non-solvent based dry cleaning technologies. Figures 7-7 and 7-8 compares the cleaning performance and physical properties of currently available dry cleaning agents, respectively.

FIGURE 7-7 | PERFORMANCE COMPARISON OF DRY CLEANING AGENTS

Solvent	Cleaning Performance and Considerations
Liquid Carbon Dioxide	Cleaning process occurs at room temperature; therefore, stains are not set during cleaning and if needed, can be further treated after cleaning. All of the carbon dioxide is distilled and re-collected after the wash and rinse cycles. Dirt removed from garments is collected in a container and can be disposed of with non-hazardous solid waste.
PCE	Most commonly used dry cleaning solvent in U.S. mainland. Because conventional dry cleaning operates at high temperatures, stains must be pretreated so that the heat won't set them permanently. Effective in removing most types of soil, particularly ink- and oil-based stains.
TCE	More aggressive on fabrics than PCE, so not widely used as a dry cleaning solvent. However, commonly used as spot cleaner.
Petroleum Hydrocarbons	Milder solvent than PCE and TCE; gentler towards dyes and plastics and therefore a preferred solvent for cleaning more sensitive items such as leathers and plastic trimming. However, less effective in removing some types of stains. Limited use due to flammability, difficulty in drying, and susceptibility to odors.
Valclene (Freon 113)	Similar cleaning performance to hydrocarbons while not having resulting odors or drying and flammability issues. Not used commercially due to ozone depleting properties.

FIGURE 7-8 | PHYSICAL PROPERTY COMPARISON OF DRY CLEANING AGENTS[18]

Solvent	PCE	Valclene	1,1,1 TCA	Petroleum	Water	CO2
Solvent Power (Kb) The higher the Kauri butanol value (Kb), the more aggressive the solvent.	90	31	124	27-45	–	Similar to petroleum
Density (g/ml) Important for conventional processes in which "solvent drop" is used to impart the necessary mechanical action for cleaning.	1.6	1.6	1.3	0.78	1.00	0.9-0.6*
Surface Tension (Dynes/cm) Measure of the ability to wet a fabric. The lower the surface tension, the easier it is to wet a fabric.	32.3	18	25.6	27.6	72	5
Flash Point (°F) Temperature at which the agent will ignite.	None	None	None	140-149	None	None
Solubility of Water in Solvent Generally, the more soluble a solvent is in water, the easier to remove water-soluble stains.	0.01	0.009	0.05	0.01	N/A	0.1
Viscosity (cp) Measures a solvent's ability to flow. The lower the viscosity, the easier the solvent can "flow" within fibers of a fabric.	0.54	0.7	0.9	1.2	0.89	0.07
Exposure (TLV) (ppm) Health and safety exposure limit of exposure.	100 (50)(25)	1,000	200	200	–	5,000

* Densities in range of 7°-30°F

18 Provided by COOL Clean Technologies, Inc. (see references in Section 10).

7.5 Ensure Proper Chemical Storage

Whether using chlorinated solvents or less-hazardous alternatives, garment manufacturers should ensure safe handling of spot removers and other hazardous chemicals through proper management and storage. Figure 7-9 provides a safety checklist for management of hazardous materials.

FIGURE 7-9 | HAZARDOUS CHEMICAL SAFETY CHECKLIST

Safety Checklist	Yes	No	NA
Hazardous Materials Management and Use[19]			
1. Are flammable chemicals stored in specialized storage rooms or cabinets?			
2. Is chemical compatibility considered?			
3. Is spark-proof electrical equipment provided in flammable storage rooms?			
4. Are chemical storage rooms ventilated?			
5. Are provisions made to prevent excessive heat or freezing of stored chemicals?			
6. Does an inventory system exist for chemicals?			
7. Are records kept on the shelf life of chemicals?			
8. Are chemical containers labeled properly and clearly?			
9. Do emergency cleanup procedures exist for chemicals?			
10. Are adequate adsorptive materials and neutralizing agents available?			
11. Has the fire department been notified of any hazardous chemicals or pesticides stored at the location?			
12. Are aisles and emergency exit routes cleared?			
13. Are material safety data sheets available for each chemical?			
14. Is safety training provided to employees who are required to handle hazardous chemicals?			
15. Is exposure monitoring performed where and when necessary?			
16. Do employees participate in the Occupational Medical Monitoring Program?			

19 Adapted from U.S. Department of Agriculture Safety Inspection Checklist.

FIGURE 7-9 | HAZARDOUS CHEMICAL SAFETY CHECKLIST

Safety Checklist	Yes	No	NA
Hazardous Waste Storage[20]			
1. Are waste storage containers marked with the words “hazardous waste” and the accumulation start date?			
2. Is the container is in good condition and non-leaking?			
3. Is the hazardous waste compatible with container that it is stored in?			
4. Is the container closed except when adding or removing hazardous waste?			
5. Is the container stored in a way that would not cause it to spill or leak?			
6. Does the facility conduct weekly inspections of the storage area?			

[20] Adapted from EPA Region 9 Resource Conservation and Recovery Act (RCRA) Hazardous Waste Storage Area Checklist..

8.0 MARKETING ENVIRONMENTAL PERFORMANCE

Communicating the organization's commitment to the environment can be an integral part of any competitive business plan. Whether interacting with employees or customers, a company that voluntarily shares information regarding its environmental initiatives and specific program results can build trust, confidence, and loyalty. This section provides specific recommendations for communicating environmental performance to customers and conducting outreach to employees as a way to facilitate change, solicit participation, and ensure compliance.

8.1 Marketing Environmental Performance to Customers

In a globally competitive industry, Saipan garment factories can gain the attention of retail clients by actively communicating their environmental performance. Retailers around the world are facing increased public awareness regarding supply-chain management. As a result, many retailers will value garment factories that voluntarily provides information regarding its environmental programs because it:

(a) Helps them document their environmental stewardship for their customers, and

(b) Saves them time in evaluating and auditing their suppliers.

A garment factory can leverage environmental performance as a distinguishing factor by various means, ranging from having a corporate environmental policy statement to maintaining detailed environmental performance metrics. The following sections discuss two of the most recognized methodologies of communicating an environmental commitment: sustainability reporting and environmental management systems (EMS).

8.1.1 Sustainability Reporting

Building on the foundation of traditional corporate financial reports, sustainability reports are intended to increase the transparency of business operations by openly sharing information regarding social and environmental performance. Sustainability reporting is perhaps the most formal and comprehensive approach to publicly communicating economic, environmental, and social performance. As discussed in Section 3, GRI has developed globally applicable Sustainability Reporting Guidelines and is currently developing an Apparel and Footwear sector supplement to identify industry-specific issues not directly addressed in the core guidelines (see Section 10, References and Further Reading). This will include sector-specific performance indicators and commentary on applying the guidelines.

The Global Reporting Initiative is currently developing an apparel and footwear sector supplement to its Sustainability Reporting Guidelines.

Saipan garment factories should understand the basic content of GRI-based sustainability reports so that they can align their environmental initiatives or at a minimum anticipate customer requests. An increasing number of retail companies—such as Gap, Nike, and adidas-Salomon—have implemented annual sustainability reporting. As this practice becomes more common, retailers may look to require similar reporting from their supply chain. Fortunately, the GRI sustainability reporting guidelines provide prescriptive instructions on what information should be included while leaving enough flexibility for organizations to tailor the document to meet the needs of their operations.

8.1.1 Environmental Management Systems

An Environmental Management System (EMS) is a formal, documented approach to assess environmental aspects and impacts, set goals for improvement, and ensure compliance. Similar to quality programs, EMSs are modeled on continual improvement through a "plan, do, check, act" cycle. The basic components are: determining the organization's "significant environmental aspects" (the most important parts of the environmental footprint described in Section 3.0), setting "objectives and targets" (quantifiable goals with deadlines), and then collecting monitoring data to analyze progress. These core EMS components are driven by an overarching environmental policy that and a variety of documentation, auditing and review procedures that together ensure the system is followed and is improving.

Garment factories that determine their environmental footprint for the four focus areas in this guidebook and identify applicable and cost effective BMPs will have completed approximately 75% of the effort required for most EMSs.

ISO 14001 is the most recognized EMS standard worldwide, but many other EMS models exist and are useful. In fact, many companies implement successful EMSs that contain most of the ISO 14001 requirements, but that are simpler in structure, require less documentation and do not require an external auditor. No matter what type of EMS an organization decides is appropriate for their circumstances, EMS data and environmental achievements are ideal for differentiating performance to customers.

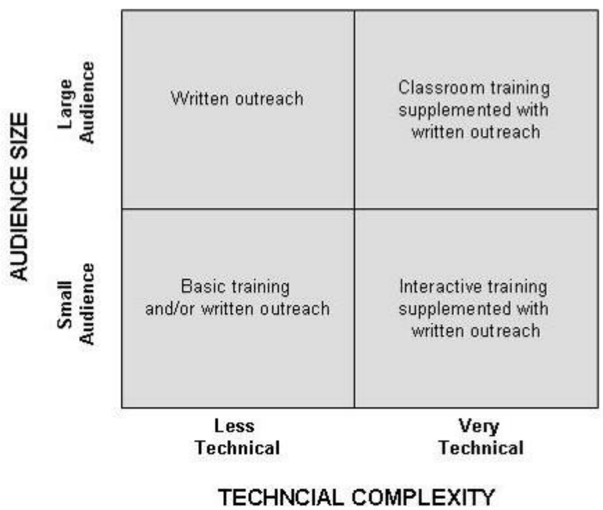
Saipan garment factories should consider EMSs for reporting environmental performance internally as well as to customers and other interested external parties. Factories that determine their environmental footprint for the four focus areas in this Guidebook: energy, water, solid waste, and hazardous materials, and then identify the applicable and cost effective BMPs described in Sections 4.0 through 7.0 will have completed approximately 75% of the effort required for most EMSs.

8.2 Employee and Resident Outreach

Communicating information regarding specific environmental initiatives to factory employees and residents is integral to the successful of the program. Doing so facilitates change—such as implementing a new leak detection program or a recycling effort—by providing employees with the context and meaning behind such efforts. More importantly, an effective outreach program can help garner acceptance for change and establish grassroots involvement in environmental programs. For example, residents who understand that the organization is proactively trying to conserve water may be more likely to voluntarily report a leaky toilet or be more accepting of low-flow showerheads.

The most effective environmental outreach programs use a variety of ways to capture the attention of the intended audience. Consider both the technical content and intended audience when determining what outreach method is most appropriate. As shown on Figure 8-1, printed outreach materials are appropriate for conveying less-technical information to large audiences, while formal training is more appropriate for conveying more technical information to small audiences. Of course, it is also important to understand that outreach is not a one-time effort; successful outreach programs raise awareness and influence change by becoming a part of the working environment through frequent and consistent communication. The following sections provide examples of outreach programs that can help capture the attention of employees and residents, ultimately improving the awareness of and participation in environmental programs.

FIGURE 8-1 | OUTREACH AND COMMUNICATION METHOD MATRIX



8.2.1 Training Programs

Proper education and training (regardless of the technical content) is imperative when conveying new ideas or implementing a process change. Formal training can establish a dedicated learning environment explicitly intended to deliver new information, whether it be sharing information on energy conservation efforts or providing instructions on new waste segregation procedures.

> **A training "rule of thumb" holds that people learn and retain:**
>
> - **50% of what they see and hear**
> - **70% of what they say**
> - **90% of what they do**

By providing training, the organization demonstrates that the content is important enough to warrant special attention. As a result, training programs are effective in establishing new management procedures and can instill a sense of personal accountability in attendees. For example, employees that receive specific training on new recycling procedures will be more likely to be a champion of the program than if they simply observed new recycling containers in the facility.

Perhaps most importantly, training can be the most effective way to ensure that things "get done right." Classrooms provide an opportunity to convey the details of a new program or process and offer employees a safe learning environment to ask questions. Of course, the delivery method for the training is equally important as the technical content. Consider the following when developing environmental training programs:

- **Interactive training and participant involvement.** Training programs can be more effective when they are designed to directly involve attendees, thus providing greater opportunities for interaction and increasing information retention. Asking direct questions and facilitating discussion are examples of simple ways to getting participants involved.
- **Hands-on activities to demonstrate learning objectives.** Communicating technical information can be enhanced by integrating hands-on exercises, demonstrations, and problem solving. For example, demonstrating reduced water use through installation of a toilet displacement bag would provide participants with visible evidence of water conservation.

8.2.2 Outreach Materials

While effective, training is not practical for daily outreach; however, printed materials such as posters and fact sheets can serve as reminders of important programs and procedures. The appropriateness of this communication method depends largely on the information being conveyed and the intended audience (see Figure 8-1). For example, instructions for operating a laundry water recovery tank may be too detailed and technical to be solely communicated in writing. In this case, it would be more appropriate to first provide a hands-on training and demonstration and then supplement the training with a printed procedure for future reference.

Printed outreach materials are very appropriate for conveying less-technical information to large and small audiences. Examples of written environmental outreach materials that could be used by Saipan garment factories include:

- **Written policies and procedures,** such as environmental policy statements or recycling procedures.
- **Posters** conveying simple conservation concepts, such as turning off lights or reporting water leaks.
- **Bulletin boards** sharing retail customers' social and environmental policies.

8.2.3 Recognition and Incentive Programs

Recognition and incentive programs can promote environmental programs by encouraging participation and instilling pride in proactive employees. Recognition programs are often cyclical; for example, issuing a monthly "Green Garment" award to individuals who exceed their job duties to help improve the environmental performance of the factory. Internally publicizing the name and achievements of the award winner or otherwise formally presenting the award can enhance the impact of recognition programs.

Incentive programs take public recognition one step further by providing some form of compensation as a result of positive environmental actions. While often associated with monetary awards, incentive programs could also provide other forms of compensation such as material goods, gift certificates, or paid leave from work.

9.0 RETAILERS GREENING THE SUPPLY CHAIN

Retailers doing business in Saipan and around the world have the ability to influence the environmental performance of garment factories by integrating environmental considerations into purchasing decisions and quality assurance compliance inspections. As Ford Motor Company has done to monitor the environmental performance of its supply chain, retailers can leverage demand-side buying power to require garment factories to report environmental metrics and encourage implementation of sustainable manufacturing processes. Because many retailers are already actively monitoring garment factory operations as part of global human rights and health and safety programs, the addition of an environmental component could simply modify these existing procedures.

Retailers can leverage demand-side buying power to require garment manufacturers to report environmental metrics and encourage implementation of sustainable manufacturing processes.

The Garment Manufacturing Environmental Performance Checklist included in the beginning of this Guidebook is designed to assist retailers in integrating environmental performance monitoring into existing supply chain management programs. Where appropriate, the GRI environmental performance indicator is noted for each category, and additional information for most recommended BMPs can be found throughout this Guidebook. Retailers should note that this checklist:

- Is wholly based on findings from the Saipan Green Garments Project, which encompasses the garment manufacturing processes described in Section 2. Therefore, the checklist does not directly address other environmental impacts that may be associated with the textile manufacturing process.
- Should be viewed only as a starting point for sustainable practices and used to initially gauge the environmental performance of suppliers. Even if a garment factory has achieved everything on the checklist, countless other opportunities exist to further minimize environmental impacts.
- Is specific to local conditions in Saipan and its application in other geographic areas or non-tropical climates may require modification to better reflect locally available P2 opportunities and operating conditions.

Garment factories in Saipan may want to proactively promote their environmental commitments and achievements to current and potential customers. Garment factories can adopt Environmental Performance Checklist in its entirety or make modifications or deletions and then share it with customers to differentiate the garments they produce from others around the world. Whether an individual factory or a group of companies (e.g., SGMA member companies), the steps for adopting a common document containing an agreed-upon list of environmental BMPs are as follows:

- **Gain Consensus on Standards/BMPs:** Use the checklist provided in this section as a starting point and through discussion and research modify the list to achieve agreement on a final list.
- **Identify Resources:** Identify resources including research, case studies, experiences and staff at other Saipan garment factories, regulators, consultants, and vendors, that can help implement the list of BMPs.
- **Monitor Progress:** Track everyone's progress in implementing the BMPs and provide incentive and assistance where necessary.
- **Promote:** Develop a "marketing plan" that identifies your target audience and the best materials for conveying accomplishments.

10.0 REFERENCES AND FURTHER READING

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20 Ways to Save Energy Now: Steam Boilers. U.S. Department of Energy, Office of Industrial Technologies. Online at: www.eere.energy.gov/consumer/industry.

Building Upgrade Manual. U.S. EPA, Energy Star Program. Online at: www.energystar.gov/index.cfm?c=business.bus_upgrade_manual.

Electronic Direct Drive Lockstitch Bar Tacker, KE-430D. Brother Industries Ltd. Online at: http://pub.brother.com/pub/com/ism/pdf/ke430d.pdf

Evaporative Cooling. California Energy Commission, Consumer Energy Center. Online at: www.consumerenergycenter.org/home/heating_cooling/evaporative.html

Portfolio Manager. U.S. EPA, Energy Star Program. Online at:

www.energystar.gov/index.cfm?c=evaluate_performance.bus_portfoliomanager.

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Laundries: Save Water, Money, and the Environment. Sydney Water, Every Drop Counts Program. December 2001. Online at: www.sydneywater.com.au/Publications/FactSheets/SavingWaterLaundries.pdf.

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Return Condensate to the Boiler, Energy Tips, Tip Sheet #8. U.S. Department of Energy, Office of Industrial Technologies. June 2001. Online at: www.energystar.gov/index.cfm?c=business.EPA_BUM_CH9_HVAC.

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How to Buy a Water Saving Showerhead. U.S. Department of Energy, Federal Energy Management Program. Online at: www1.eere.energy.gov/femp/procurement/eep_showerhead.html.

How to Conserve Water and Use it Effectively. U.S. Environmental Protection Agency, Office of Water. Updated March 2003. Available Online: www.epa.gov/owow/NPS/chap3.html.

Water Conservation Tips. San Francisco Public Utilities Commission, Water Conservation Section. Online at: http://sfwater.org/mto_main.cfm/MC_ID/16/MSC_ID/172/MTO_ID/610

Consumer Water Center, Conservation Resources. American Water Works Association. Online at: www.drinktap.org/consumerdnn/Home/WaterInformation/Conservation/tabid/66/Default.aspx

Home Water Conservation: Toilet Retrofit Devices. City of Iowa City. Online at: www.icgov.org/water/ waterretrofit.htm.

Focus Area 3—Solid Waste

Business Guide for Reducing Solid Waste—Appendix D: Volume to Weight Conversion Table. Environmental Protection Agency. 1993. Online at: www.epa.gov/epawaste

Disposal Information and Material Recovery Facility/Recycling Center Information Sheet. Department of Public Works, Solid Waste Management Division. May, 2, 2005.

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Focus Area 4—Hazardous Chemical Use

APHIS Safety Inspection Checklist, U.S. Department of Agriculture. Online at: www.aphis.usda.gov/library/forms/pdf/aphis256_5.pdf

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Dry Cleaning Dreams, Chemical and Engineering News. Volume 83, Number 46. November 14, 2005. Online at: pubs.acs.org/cen/coverstory/83/8346specialtychem2.html

Resource Conservation and Recovery Act (RCRA) Storage Area Checklist, U.S. Environmental Protection Agency, Region 9. Online at: www.epa.gov/region09/waste/rcra/ca/storage.htm

11.0 VENDOR INFORMATION

Energy Efficient Sewing Machines

Brothers Technologies, Inc.
China Regional Website:
http://www.brother-cn.net/

Continuous Batch Systems and Washer Extractors

Girbau Commercial Laundry Division
US BRANCH
Oshkosh, WI 54904-2500 State Road 44
Phone: 920-231-8222
www.cont-girbau.com

CHINA BRANCH
Tsuen Wan, Hong Kong, Rm.710, 7/F.,
TCLTower, 8 Tai Chung Road
Phone: 852–3427-8533
www.girbau.com.cn

Pellerin Milnor Corporation
PO Box 400
Kenner, LA 70063-0400
Phone: 504-467-9591
www.milnor.com

Ozone Washing Systems

Envirocleanse Systems, Inc.
5150 Palm Valley Road, Suite 206
Ponte Vedra Beach, FL 32082
Phone: 888-420-4262
www.envirocleanse.com/default.htm

Green Suites International
Upland, CA
Phone: 800-224-4228
www.greensuites.com

Boiler Condensate Units

Power Plus International
309 Westridge Parkway
McDonough, GA 30253
Phone: 800-780-3776